The Welding Engineer

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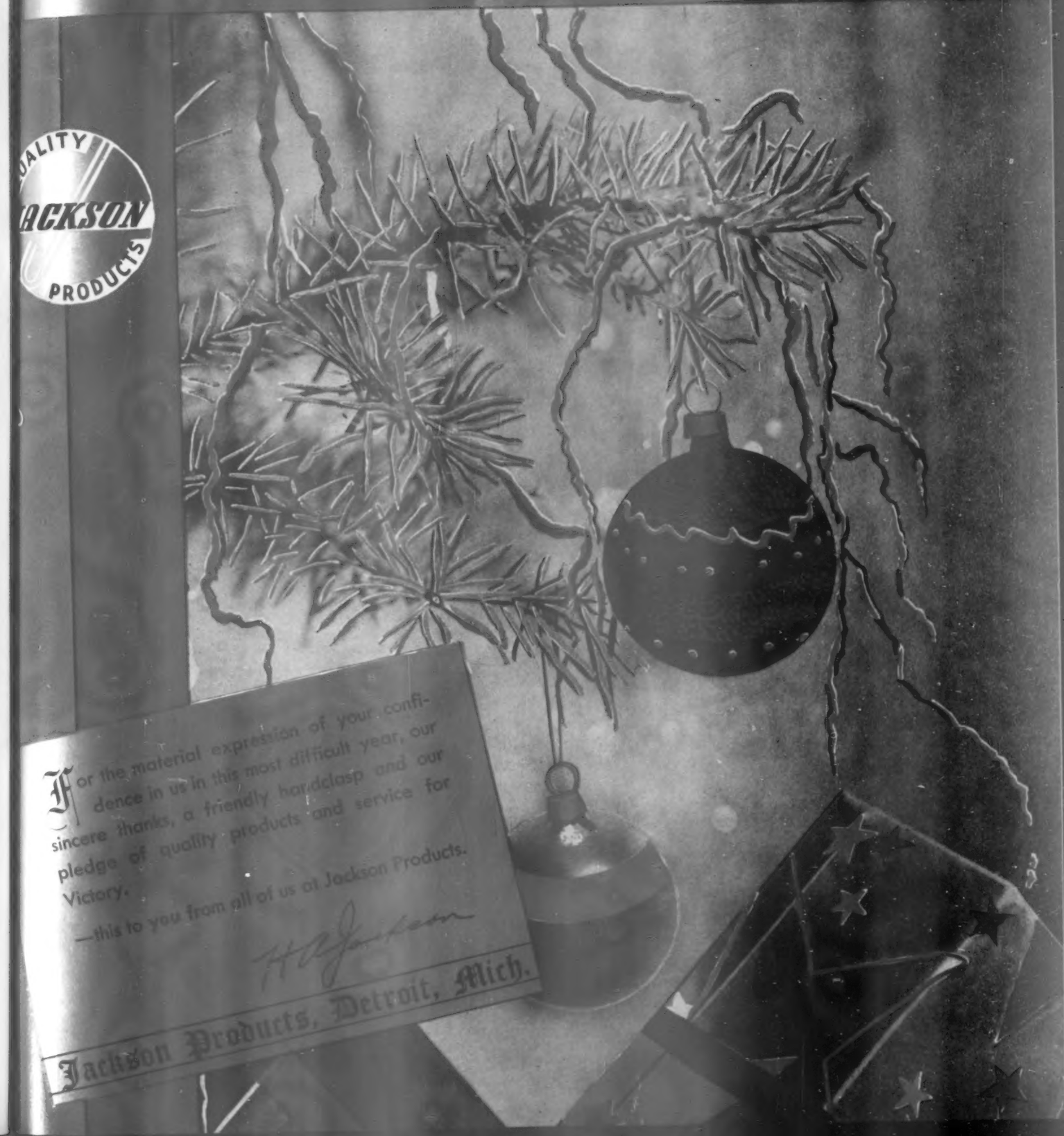
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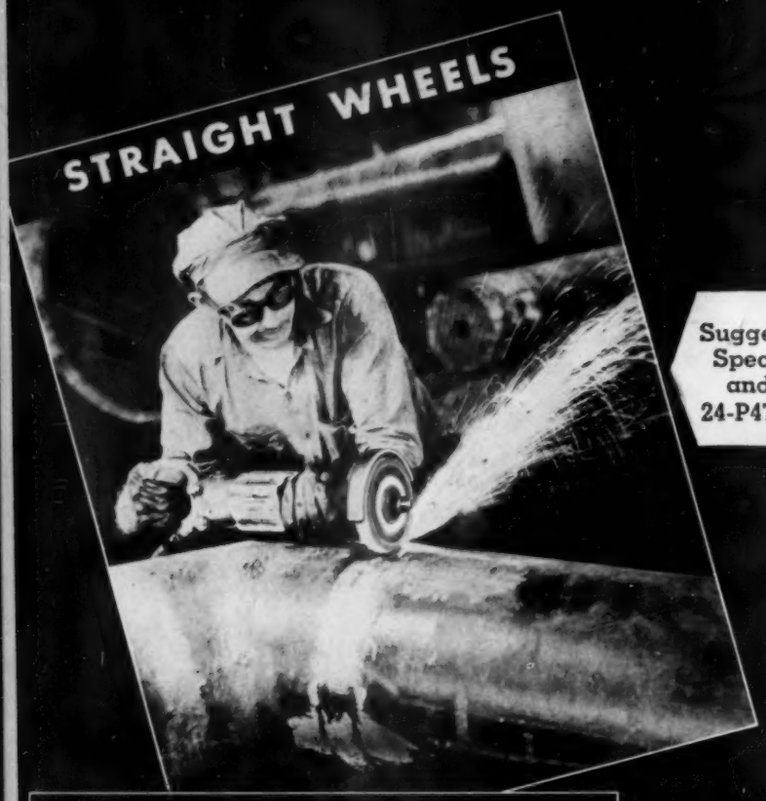
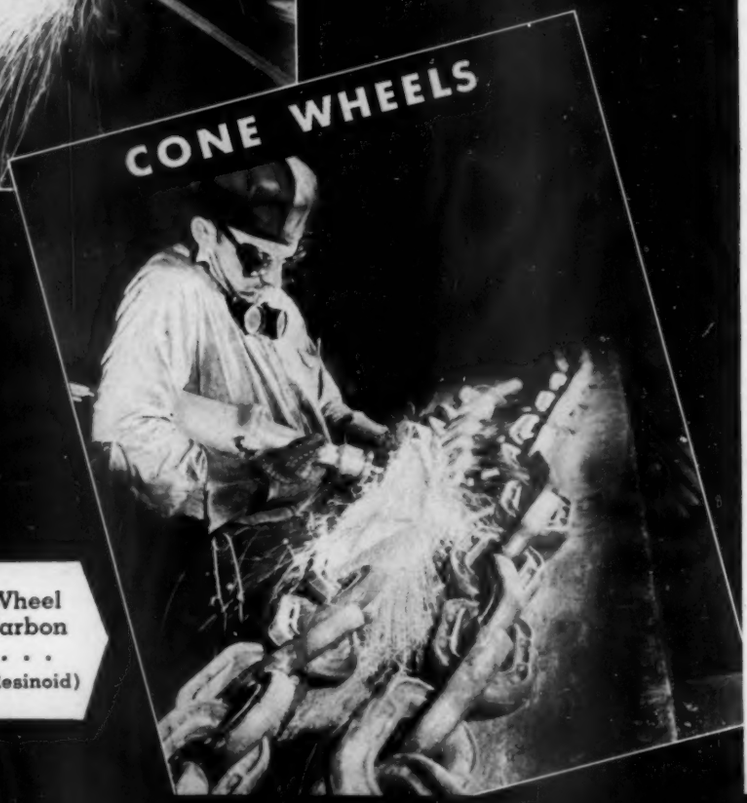


Suggested Straight Wheel Specification for Carbon and Alloy Steels . . . 24-P4T-H (Alundum-Resinoid)

Suggested Cup Wheel Specification for Carbon and Alloy Steels . . . 16-P4T-H (Alundum-Resinoid)



Suggested Cone Wheel Specification for Carbon and Alloy Steels . . . 24-R4T-H (Alundum-Resinoid)

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The Welding Engineer

Vol. XXVII, No. 12 December, 1942

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O'FALLON, ILLINOIS

The Welding Engineer

AMERICA'S PIONEER WELDING JOURNAL

Established 1916

MAKE THEM LAST

Rationing is designed to "make them last." Some people feel that rationing is too severe while others would welcome rationing. Particularly if the rationed items were welding electrodes.

The distribution of welding electrodes is now controlled by priority regulations and the operators of the small welding shops will tell you there is a vast difference between rationing and priorities.

According to the job shop operator, rationing gives everyone a little of the rationed items. These small quantities are carefully guarded and wisely used so that they will last as long as possible. Priorities, on the other hand, give some users large quantities of scarce materials and deny others the use of any of these materials. Those who receive the large quantities proceed to use some and waste some while the less fortunate are forced out of business.

This conception of the difference between rationing and priorities may not be entirely correct. It does, however, represent the observations of many job shop operators who have seen the workings of gas rationing and welding electrode priorities.

Unfortunately, it is true. We are wasting welding electrodes while carefully watching the gasoline supply in our motor cars.

Welding has proved itself the most effective and efficient means of joining material used in the building of armament. Yet, daily we see electrodes wasted before they have been fully utilized.

This practice could be corrected by the weldor himself and a little thoughtfulness on the part of each operator will mean much in the production of armaments. Too often the operator assumes that it is not his responsibility—that there are more electrodes where these came from. Unfortunately, that is not the case. Electrode production in 1942 will nearly double that of 1941, yet even this is not enough. The demand is still much greater than the available supply.

The welding electrode is made up of many critical materials. These materials include not only the steel or steel alloy core wire but also the materials which go into the flux coating.

We can conserve welding electrodes by storing them in a dry place. Should electrodes become wet, dry them immediately. And don't bend the welding electrodes. If bending is necessary, bend them close to the holder. The most wasteful practice, however, is that of discarding electrodes before they have been fully utilized. The electrodes can be burned down to a two inch stub without inconvenience to the weldor and without any sacrifice of welding quality. In many cases the electrode can be burned even closer than two inches.

When a long stub end is thrown away it may seem that little is lost. Consider, however, how few of these stubs ends are required to make a pound of electrode and that close to 2,000,000 lbs. of electrode are used each day. You will see how stubs can become a very important matter.

Let's keep our armament plants busy by conserving welding electrodes. It will be much wiser for weldors to stop their wasteful practices than to stop armament production (and their own work) because of an electrode shortage.

A Merry Christmas to you!

J. B. Jefferson

It Takes a Beach-Head to Start an Invasion

This welded steel amphibian tractor is the Marines' answer to tough "competition" that beat us to the offensive, then dug in.

ALTER EGO: Those few Marines may not win the war by themselves, but they will establish a beach-head and that's a mighty vital prelude to dislodging Axis "competition".

Yes, war is like that. Business now is somewhat like that. Business after the war will be just like that!

ALTER EGO: Right. To win the Battle for Business after this war we're going to have to get on the offensive with welded steel products.

Right. But first we must establish our beach-heads of welding knowledge. Let's start this prelude to invasion of the post-war market NOW.

Ask your inner self if a "beach-head" of welding knowledge shouldn't precede post-war market invasion.

THE LINCOLN ELECTRIC COMPANY
CLEVELAND, OHIO

then I said to myself—

MARINES and WELDING
—the situation will be well in hand

★ RESEARCH

Fumes from Arc Welding

When welding in the open or in a large, well-ventilated shop, arc fumes are scarcely noticeable.

Official OWI Photo by Palmer

When electrode and parent metal are melted in the intense heat of the electric arc, a certain amount of smoke and gas is formed. These fumes come partly as a result of the consumption of the electrode coating and partly from the metal. Can they harm the weldor? Authorities say, "No!"

THOUSANDS of workers are embarking on careers in war production industries which, for the first time in their lives, will take them into shops. Many of these newcomers, entering into the welding field, are disturbed by rumors circulated with regard to the physical hazards to which arc weldors are subjected. Because the nature of their work requires them to be exposed to the fumes and smoke of the welding arc day in and day out, it is only natural that arc weldors and prospective arc weldors would want to know: Is there a health hazard from working in arc welding fumes?

Authorities say, "No!" Science has thoroughly investigated the problem and given arc welding a clean bill of health on virtually all counts.

There have, of course, been cases where weldors, working inside tanks, pipe tunnels or other confined and badly ventilated places have succumbed. In some of these cases, fumes have been held responsible when the true cause was simply deprivation of air. The effect would have been the same (or greatly enhanced) if these men had tried to work inside an ill-ventilated enclosure with a wood fire instead of an electric arc to burn up the oxygen and give off smoke.

When welding in the open or in large, well-ventilated shops, arc fumes are scarcely noticeable. Their odor is mild. There is nothing at all obnoxious about the fumes of arc welding except that in abnormally heavy concentrations they cut down the amount of fresh air taken into the lungs, causing the breather to feel "stuffy" as though the air was full of dust. The remedy is simply a matter of more adequate ventilation.

There are some important exceptions to the general statement that welding fumes are not harmful. Lead and cadmium fumes are dangerous. So, although to a lesser degree, are the zinc fumes produced from brazing operations or from welding galvanized steel.

General Health

Over 200,000 weldors—about half of them veterans of 10 to 20 years' experience—can attest to the fact that the fumes of arc welding are not detrimental to the breather's health. So can medical authorities. Doctors J. A. Britton and E. L. Walsh, Dept. of Industrial Medicine, Northwestern University,[1] studied the sickness disability records of 189 weldors in a manufacturing plant employing 50,000. The study extended over a period of two years, 1937 and 1938, and took into account "disabilities," which were defined as illnesses of one week or more. Here's how weldors' disabilities compared to those of employees in general:

	Av. Length of Disability in Weeks	Frequency of Disability per 1,000 Employees
1937		
Weldors	5.7	77
Employees	5.5	99.5
1938		
Weldors	5.7	48
Employees	8.5	104.9

Other authorities may also be cited to show that the health of arc weldors in general compares very favorably with those of men in other trades. Here are a few quotations from the writings of those who have investigated the situation:

"It does not appear that the health of arc weldors as a class may be set apart as especially different to metal workers in general."[2]

"We have found nothing in the course of our laboratory studies or field investigations to condemn modern welding practice or to indicate that arc welding operations are in

Artificial ventilation should be used to carry off the fumes whenever welding is done in restricted spaces.

Official OWI Photo by Palmer

the least difficult to render perfectly safe."[3]

"At lowered concentrations . . . the incidence and severity of respiratory lesions were so greatly diminished that the harmlessness of welding fumes at industrial concentrations seems a fair assumption."[4]

"Twenty years of welding experience with electrodes . . . seems to indicate that electric welding is not a hazardous occupation provided the fume concentration is kept below a certain level."[5]

"The disability frequency rate of weldors has not been in excess of that found in a general group. The diseases found have otherwise not differed from those occurring in a general group of workers."[1]

Colds and Tuberculosis

Do the fumes of arc welding tend to aggravate colds? There is not the slightest evidence for it. On the contrary, weldors have reported that their resistance to colds increased after they had taken up the welding trade.[5]

The lungs of weldors do not appear to be more susceptible to tuberculosis.[5] Exposure to even excessive concentrations of arc welding fumes is unlikely to have a bad effect upon either fresh or old tuberculosis foci (area) in a weldor's lungs.[6]

Silicosis

Silicosis is a respiratory disease, encountered in some mining operations where conditions are very dusty. In these mines, the miners are required to use respirator masks. There is, however, no reason for arc weldors generally to wear such masks, even though silicates are often used as a binder for electrode coatings.

Investigations have shown that silicosis or related dust diseases are not brought about from silica dust exposures incident to arc welding and do not have to be considered as possible factors in the welding industry.[2, 4] The amount of silica involved at even relatively high concentrations was found to be well below the toxic levels.[4]

Iron Fumes

Iron oxide in the form of a fine dust is one of the natural constituents of arc welding fumes when steel or iron is being welded. This is not harmful. Deposition of iron oxide in the lungs does not seem to occur to an appreciable degree, unless the work is very confined, causing massive concentrations of iron particles in the fumes.[7] Even where the quantities of iron fumes produced from the welding rods were so large as to be discomforting, there was no indication that these fumes were specifically harmful.[8]

When iron oxide particles are less than one half micron in diameter, concentrations may run as high as 2 to 3 million particles per cu ft without any harmful effects.

Oxygen and Ozone

The electric arc resembles a fire in that it consumes oxygen in chemical action to produce oxides of various minerals or gases such as carbon dioxide. The amount of oxygen so consumed, however, is not great enough to constitute a hazard even when the welding is being done in a small, confined space. Three investigators conducted studies in which the rate of electrode consumption was much higher than normal use and the welding was done in a comparatively small chamber of 1,000 cu ft with, at times, only one air change per hr. They were not able to detect even a suggestion of oxygen deficiency.[2]

Through the action of the electric arc, a portion of the air's oxygen is converted into a faintly blue gaseous substance with a peculiar "electrical" odor like that of weak chlorine. This is ozone, an allotropic form of oxygen which has the chemical formula O_3 and is 1½ times as dense as ordinary oxygen.

While some authorities state ozone to be harmful if breathed in large quantities, it is extremely doubtful if it is anything but a theoretical hazard in welding.[9]

Immediately in the arc, the ozone present ranges from 10 to 32 parts per million. At a distance of only four inches away from the arc, the ozone content of the atmosphere has dropped to 1 to 9 parts per million.[2] Obviously, the amount of ozone in the air as the result of arc welding quickly shrinks to infinitesimal percentages as the distance from the arc continues to increase. Not the slightest evidence of injury from ozone could be determined by the experimenters.[2]

Carbon Monoxide

Carbon monoxide is a colorless, odorless gas which gives no warning of its presence. It causes death by uniting chemically with the hæmoglobin in the blood, depriving the tissues of oxygen. It is dangerous in even minute quantities. An atmosphere containing but two parts of carbon monoxide per 1,000 will cause death, it is estimated, if breathed for four hours.

Everyone knows the risk of remaining in a closed garage with the automobile engine running. Carbon monoxide is formed when material containing carbon is not completely consumed. Is it a hazard to be reckoned with in arc welding?

It is not.

The carbon monoxide content of welding fumes is so low that it was extremely difficult, if not impossible, to detect.[2] If carbon monoxide is present at all, it is present in too small concentrations to be seriously regarded as a pathological factor.[4]

Nitrous Fumes

The chemical reaction of oxygen and nitrogen in the welding arc results in the production of nitric oxide and other higher oxides of nitrogen, sometimes called nitrous fumes (not to be confused with nitrous oxide or laughing gas, the anaesthetic agent of dentists). In heavy concentrations, these nitrous fumes have an irritating effect upon the lungs.[9] However, concentrations of nitrous gases greater than 20 parts per million are seldom found as a result of arc welding done in comparatively open space.[2]

The accepted threshold of injury is 39 parts per million—a somewhat arbitrarily selected figure. For limited exposures, concentrations of even double and treble this 39 ppm do not necessarily result in discernible ill effects. Human beings were exposed for three hours to such high concentrations of nitric oxides as 84 to 103 ppm without ill results.[2]

Bare electrodes were found to be more productive of nitrous gases than were coated electrodes.[2]

Zinc Fumes

The zinc vapors encountered in the welding of galvanized iron or in brazing operations are by no means as dangerous as is generally believed. Practically their entire effect upon the weldor is to produce an attack of the illness known as zinc chills or metal fume fever. This is an unpleasant but not especially serious illness. An attack usually lasts not longer than 24 hours and has no known after effects or complications. It is said that victims will soon develop an immunity which will permit continued exposures to zinc fumes without other ill effects.[9] Even though such an immunity may be developed, the inhalation of zinc fumes is never to be advocated. The said immunity may be lost should there be a lapse of several days between exposures, with possible recurrence of zinc chills.

Some weldors, because of their physical make-up, will not develop an immunity and hence will experience zinc chills whenever they are exposed to fumes of this metal. These men should be made to wear respirators if it is necessary for them to do welding upon zinc-bearing material. Whenever galvanized material is to be welded in the holds of ships or other confined places, ventilation should be adequate to prevent excessive concentrations of zinc fumes.

Cadmium and Lead

Cadmium fumes, which may produce a pulmonary irritation and edema similar to that resulting from inhalation of the nitric oxides previously mentioned, constitute a far more serious health hazard than zinc fumes.[9] Cadmium is now being rather widely used as a rust-proof protective plating on steel, and it enters into some alloys. When welding a cadmium-bearing material, good ventilation is absolutely essential. For complete protection, it is desirable that air-supplied masks be worn.

Lead fumes are even more dangerous than those of cadmium,[9] but lead-bearing materials, fortunately, will not be frequently encountered in welding operations other than low-temperature lead soldering.

Manganese

One other element may be mentioned as having possible ill effects if breathed in vapor form. Some authorities believe that manganese fumes will affect the nervous system if breathed for long periods in high concentrations. Von Haam and Groom could not find any evidence of manganese effects in their experimental animals.[4] In Scandinavian medical literature, the claim has been made that smoke containing a high percentage of manganese may predispose individuals to pneumonia.[4] This is not born out by the known experience of welding operators.[9]

Summary

Under normal working conditions, the fumes from most arc welding operations are not harmful. Heavy concentrations of fumes should be avoided, but such concentrations, as a rule, can occur only when the welding is done in confined spaces. Artificial ventilation should be used to carry off the fumes when welding is done in restricted spaces, particularly inside tanks, boilers, pipe tunnels, etc. Ventilation is especially necessary if materials bearing zinc, lead or cadmium are to be welded.

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Fresh-air masks are sometimes necessary to protect weldors against zinc chills when they are working upon galvanized material.

Official OWI Photo by Palmer

★ RESEARCH

Arc Welding Magnesium Alloys*

★ Part One—An important new tool is provided by recent development of a practical process for the arc welding of magnesium. The range of weldable alloys has been widened to include all the commercial alloys.

By **W. S. LOOSE** *and* **A. R. ORBAN**
The Dow Chemical Co., Midland and Bay City, Mich.

Fig. 1—Automatic equipment used in study of arc welding variables.

USING the inert gas arc process, maximum strength joints having exceptionally good corrosion resistance may be produced in magnesium alloys. All the commercial alloys may now be welded by this process. Because no flux is required, any type of joint customarily used in the welding of steel may be employed.

A recent patent by Meredith (U. S. 2,274,631) of Northrop Aircraft Corp., covers a torch developed to introduce helium around a refractory-type electrode for the welding of metals, special reference being made to magnesium alloys.† The present process of welding by means of an arc between magnesium and a tungsten electrode encompassed by a helium or argon shroud is believed to be the first commercial exploitation of this method of welding. In many ways the new process is similar, in the use of the holder and filler rod, to carbon arc welding except that the arc is produced between a tungsten electrode and the base metal.

Both manual and automatic welding were studied. It is recognized that a very high percentage of welding that will be done by this process will be accomplished by manual operation but hand operation involved so many uncontrolled variables that a simple automatic welder was made as a research project. The results obtained by the two methods are discussed below.

Manual Arc Welding

An example of a typical hand-operated electrode holder is shown on page 33. In normal hand operation, the helium valve is opened just prior to the striking of the arc between the tungsten and the magnesium alloy. The arc is struck by a light brushing action and quickly drawn back from the metal. As soon as the metal becomes molten, the filler rod is advanced to the arc. If preferred, the rod may be pushed into the molten pool under the arc and withdrawn, similar to the technique involved in gas welding. Best results have been obtained when the rod is evenly advanced into the bottom of the tungsten. The rod should be advanced while at an angle of not less than 60 deg to the tungsten. When advanced at an angle of less than 60 deg to the tungsten, the rod becomes so hot (due to reflected heat from the tungsten) that it may become molten and fall down in large globules. This causes very uneven beads and decreases penetration.

Automatic Arc Welding

Due to difficulties encountered in controlling penetration, arc length and traverse rate with hand welding, automatic equipment was developed so that the effect of variables such as

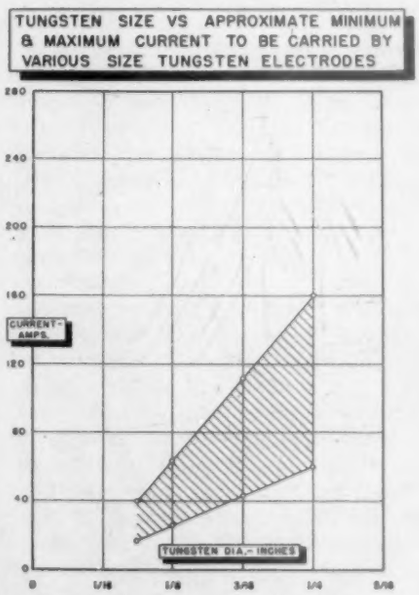


Fig. 2—Range of current allowable for different size tungsten electrodes.

*Abstract of a paper presented at the Annual Meeting, AWS, Cleveland, Oct. 12 to 15, 1942. Contribution to the Welding Research Committee. The subject matter of this paper is in part embodied in pending patent applications.

†See "Heliarc Welding" by Thomas Piper, process engineer, Northrop Aircraft, Inc., September, 1942, issue of THE WELDING ENGINEER.

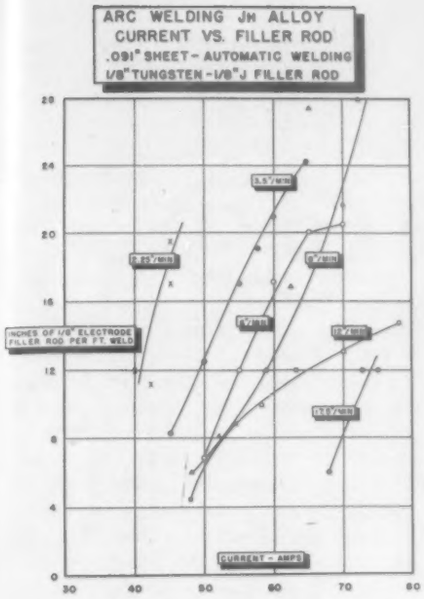


Fig. 3—Amount of 1/8 in. filler rod required to make welds with different currents and traverse speeds.

current, travel rate, etc., might be studied. This equipment is shown in Fig. 1.

A $\frac{1}{16}$ hp, constant speed, cone-drive motor operating through a gear reduction chain drive system runs the drive wheel. The latter is located directly behind the electrode cup through which the helium passes around the tungsten electrode. Travel speeds of 0.1 to 6 fpm may be obtained.

The welding table is made in two parts (one movable) to allow an open space under the arc so that penetrating metal may drop through. The welding current is adjusted by means of a table-mounted rheostat connected to the field of the generator. Current is read on a meter mounted in such a way that the operator may view it by the light of the arc. Timing is recorded by an electric self starting clock which is operated by a switch under the operator's foot.

In the initial operation of this machine, the filler rod was fed into the arc by hand, but it was found that the bead shape had such a great effect on the strengths obtained that an automatic rod feed was installed.

The filler rod should be fed into the white hot ball on the end of the tungsten at an angle of at least 60 deg away from the tungsten and, for smoothest beads, should be fed almost parallel to the plate being welded. The automatic feed, like the traverse feed, is run by a constant speed, cone-drive motor through a reduction gear and a chain drive. Rod feeds of 3 to 60 in. per min may be obtained. Perfectly symmetrical beads may be produced with this equipment.

Electrodes

The tungsten electrode used in the arc welding of Dowmetal may vary from $\frac{3}{32}$ in. to at least $\frac{1}{4}$ in., depending on the amount of current required to obtain the necessary penetration. A curve relating the size of the various electrodes to current values is shown in Fig. 2. This shows the approximate minimum and maximum values of current at which each electrode will successfully maintain an arc without becoming so overheated that it becomes molten and falls off.

Helium

The following is a typical analysis of commercial helium:

Helium	98.0%
Water	0.029%
Carbon dioxide	0.2%
Unsaturated	Nil
Hydrogen	0.2%
Nitrogen	1.6%
Hydrocarbons (CH_4)	Nil

The gases other than helium, if present in excess, may cause pronounced effects. Water vapor breaks down under the arc to give hydrogen and oxygen; this hydrogen is absorbed by the extremely hot molten metal under the arc and then released when the metal cools, producing extremely bad porosity. Hydrogen itself, when present in the helium, produces the same results. Oxygen forms a film on the metal, causing poor coalescence and inclusions. The presence of 7% nitrogen in the helium will reduce the welding speed to about two thirds that obtained when only 2% is present.

Normally, helium as purchased from the U. S. Government plant is sufficiently pure that no removal of the dilutent gases is required. Apparently because of the settling of impurities, tanks must sometimes be discarded when about 20 psi pressure remains. The development of porosity in the welds will determine whether or not this is necessary.

Helium Cups

The shape of the helium cup may vary widely. A straight-sided cup

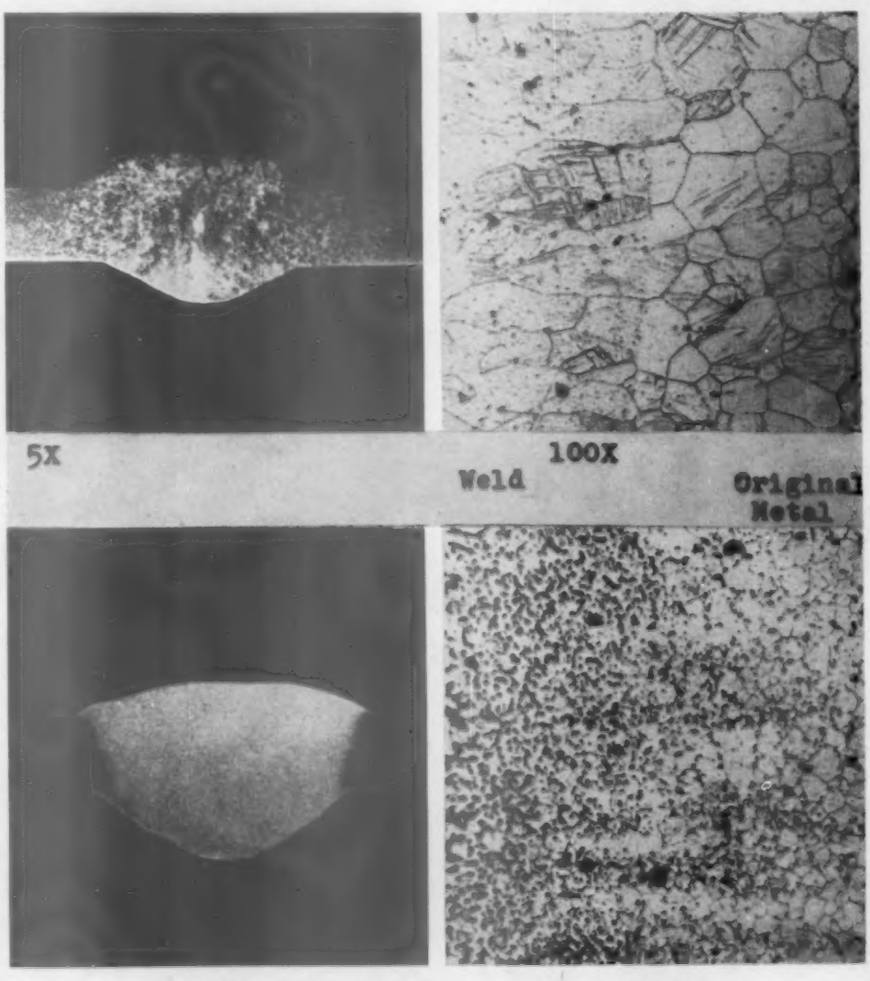


Fig. 4—Macrographs (left) and micrographs of arc welded Dowmetal M (top illustrations) and J (bottom illustrations) alloy sheets.

made of a piece of steel tubing and insulated from the current yields excellent results for either hand or automatic welding. A cup tapered at the outlet has advantages for visibility of the arc. For automatically fed units, less helium may be used if an oblong cup, shaped so that the rod is fed into the long side, is used. In automatic welding, the cup may be placed very close to the sheet, thus greatly reducing the amount of helium required to prevent oxidation of the metal under the arc.

For tungsten electrode sizes of $\frac{3}{32}$ to $\frac{3}{16}$ in., a $\frac{7}{16}$ to $\frac{5}{8}$ inch ID helium cup is large enough, but for the ¼ in. tungsten a ¾ in. ID cup should be used.

The size of the cup makes little difference on the quantity of helium required when using $\frac{3}{32}$ to $\frac{3}{16}$ in. tungsten electrodes and $\frac{7}{16}$ to ¾ in. helium cups. When using the ¼ in. tungsten and a 1 in. ID cup, slightly more helium must be used.

Effect of Welding Variables

Advantages are obtained when a very short arc is held. Using a ⅛ in. tungsten electrode, arc lengths up to about 0.100 in. may be held, but best results are obtained when the distance of the tungsten to the top of the plate is no greater than 0.060 in. Under these conditions, if there is a thin oxide film on the metal under the arc, the swirling action of the metal will normally be great enough to break up this film and produce a homogeneous structure.

Speeds of 0.1 to 2.0 fpm have been used. Best results, especially on alloys which tend to be hot short, are obtained when relatively high bead speeds are used. With increase in speed, increased currents are naturally required to get complete penetration. The amounts of filler rod required to make welds with different currents and traverse speeds are shown in Fig. 3.

When welding thicknesses greater than ⅛ in., multi-pass welds are normally used. Good single-pass butt welds have been made on plates up to $\frac{5}{16}$ in. thick using a ¼ in. tungsten electrode, but the narrow melting range of the magnesium alloys makes the effect of traverse speed and current so critical at these thicknesses that it is not recommended.

Effect of Alloy Composition

All commercial Dowmetal alloys are readily arc welded, although there are certain precautions required on those alloys of the more hot short type. All of the Dowmetal alloys that are normally rolled, such as M, FS and J, are very readily arc welded. No trouble, such as cracking, is normally experienced. They may be welded over wide ranges of current, speed and rate of adding filler rod, and with widely differing types of fabricated articles.

Higher alloy content magnesium alloys containing aluminum and zinc have a greater tendency to be hot short due to the greater amount of lower melting point compound solidifying in the grain boundaries during cooling. The effect of the zinc content is especially pronounced in this respect and appears largely to govern the weldability of the alloy. The alloys containing 7 to 10% aluminum and up to 1% zinc may be termed mildly hot short, being more critical than J alloy but much less critical than the alloy group containing 6 to 10% aluminum and 1 to 3% zinc.

Extruded, rolled or cast magnesium alloys containing 7 to 10% aluminum and 0.5 to 1.0% zinc may be readily arc welded by using a slightly higher current and traverse speed than that normally employed for J alloy. As a general guide, a minimum speed of about 6 to 8 in. per min is recommended.

The magnesium alloys of the higher zinc group, containing 6 to 10% aluminum and 1 to 3% zinc, are much more hot short; to weld them successfully, the metal under the arc must be very rapidly chilled. When welding extruded alloys, a minimum traverse speed of about 12 in. per min should be used. To get complete penetration at this speed, currents of 90 to 130 amp must be used on a $\frac{3}{16}$ or ¼ in. tungsten electrode. Currents of 110 to 130 amp are most satisfactory due to the resulting greater fluidity of the metal.

It has also been found that the strength of welds in these higher alloy content magnesium alloys is more seriously affected by minor imperfections such as oxide lines or porosity than lower alloy content materials.

The welding of cast magnesium alloys, such as Dowmetal H or C alloys of the high alloy content group, is more difficult than the welding of extruded alloys due to the larger grain size of the metal, the greater amount of porosity, and to the presence of the large globules of compound formed between the grains. The first two factors tend to weaken the metal while it is hot; the intergranular compound, due to its lower melting point, is extremely weak at elevated temperatures and

Table I. Tensile Data on Arc Welded Magnesium Alloys

Dow-metal Alloy	Form	Composition, % Balance Mg Al	Mn	Zn	Condition before Welding	Heat Treatment after Welding	Bead Condition	Tensile Strength Psi	% Elong. in 2 In.	% Weld Efficiency
Ma	Sheet	...	1.5	...	Annealed	None	On	18,000–21,000	2.0	60–70
					Annealed	None	Ground	20,000	4.0	65
Mh	Sheet	...	1.5	...	Hard	None	On	21,000–24,000	1.5	70–75
					Hard	None	Ground	22,000	4.0	72
Ja	Sheet	6.5	0.2	0.7	Annealed	None	On	39,000–42,000	6.0	95
					Annealed	None	Ground	40,000	6.0	95
Jh	Sheet	6.5	0.2	0.7	Hard	None	On	40,000–44,000	5.0	90–95
					Hard	None	Ground	40,000	6.0	92
					Hard	None	Top ground	40,000	5.0	92
J	Ext.	6.5	0.2	0.7	As ext.	None	Ground	36,000–38,000	8.0	90–95
O	Ext.	8.5	0.2	0.7	Aged	None	Ground	34,000–36,000	4.0	65
					Aged	Aged	Ground	36,000–38,000	2.0	65
H	Cast	6.0	0.2	3.0	As cast	None	Ground	28,000–30,000*	4.0	100
					As cast	HT	Ground	30,000–34,000*	9.0	90–100
					As cast	HTA	Ground	32,000–36,000*	4.0	90–100
C	Cast	9.0	0.2	2.0	As cast	None	Ground	26,000	2.0	100
					As cast	HT	Ground	30,000–34,000	4.0	90–100
					As cast	HTA	Ground	32,000–36,000	2.0	90–100

HT is solution heat treated.
HTA is solution heat treated, then aged.
* 80% of the bars broke in the shoulder or grips. Weld efficiency based on strength of original metal in same condition of HT.

tends to crack while the higher melting point matrix of the metal is undergoing shrinkage.

Corrosion

It is found in salt water tests that, unless highly corrosion-resistant magnesium alloys are used, there is a tendency for the original metal to pit slightly in the area adjacent to the weld in either cast or wrought alloys. Apparently, the weld bead is slightly cathodic to the adjoining metal. The amount of pitting adjacent to the bead appears to be almost a direct function of the corrosion resistance of the material being welded.

In practice, the welding rod is chosen to have the same alloy composition as the original base metal being welded, but, from the corrosion standpoint, only two types of alloys have to be taken into consideration. When welding Dowmetal M alloy (magnesium with 1.5% manganese) only filler rods of the same alloy should be used. When welding magnesium alloys containing aluminum or zinc, M alloy filler rod should not be used, but a rod of any alloy composition containing aluminum or zinc may be used without apparently affecting the corrosion rate. The binary magnesium-manganese alloys are more electro-negative than alloys containing aluminum or zinc so that the former will go into solution preferentially in salt water corrosion. This is due to the potential difference set up between the two alloys.

Metallography of Welded Alloys

A macrographic and micrographic study of welded joints has been made for all the Dowmetal alloys. Some of the photographs taken of typical alloys are shown in Fig. 4. A 10% tartaric acid solution was used for etching the specimens for the macrographs, the time being 20 sec. The specimens for micrographs were etched 5 sec in a solution composed of 60 parts ethylene glycol, 20 parts acetic acid, 1 part nitric acid and 19 parts water.

For the M alloy containing only magnesium and 1.5% manganese, there is a considerable amount of grain growth in and adjacent to the weld. This accounts for the lowering in strength obtained with this alloy, using either arc or gas welding. The extremely fine grain size obtained in the bead on welding a J alloy sheet is also shown. There is practically no grain enlargement adjacent to the bead. The J alloy contains 6% aluminum, 0.7% zinc and 0.2% manganese.

From these and similar pictures, it may be concluded that, with the exception of the magnesium-manganese alloys, the weld metal is extremely dense and fine grained and that there is a minimum of heating effects on the adjacent metal. This accounts for the very good weld efficiencies obtained on arc welded magnesium alloys.

Table II. Fatigue Strength of Arc Welded Joints

Dowmetal Alloy	Thickness, In.	Type Test	Fatigue Strength, Psi 100,000,000 Vibrations Original Bars	Welded Bars
J	0.064	Krause	13,000	12,000
J	0.156	Krause	12,000	11,000
C	0.500	R. R. Moore	9,000	11,500
C	0.500	R. R. Moore	10,000	12,500
C	0.500	R. R. Moore	10,000	13,500

Strength of Arc Welded Joints

The strength of helium arc welded butt joints is given in Table I. To obtain these values, it is extremely important that sufficient current be used to keep the metal fluid under the arc so that adjoining beads flow into one another to form a smooth radius. The effect of welding on the strength of Dowmetal having different tempers before welding or with different heat treatments after welding is also shown in the table. No differences in weldability due to heat treatment prior to welding have been observed, but cast H or C alloy which has been solution heat treated, or solution heat treated and aged before welding, must be re-solution heat treated to give good strengths.

As shown by the weld efficiency values in the table, it is difficult to regain the full strength of welded ageable extrusion alloys. Simple aging will only increase the strength of as-welded joints by 5 to 10%. By solution heat treating and aging, the weld efficiency may be increased to a high percentage of the original value, but this procedure is difficult, often impossible, as temperatures of 730 to 810 F for 5 to 6 hr are required to put the primary compound in the weld metal completely into solution. Jigging to hold a structure in shape would be a difficult problem under such conditions. Moreover, the long solution heat treatment at these temperatures may often cause pronounced grain growth adjacent to the weld metal if lattice strains due to machining or grinding of the base metal have been set up prior to welding. The effect of a rotary routing file is especially pronounced because of its chatter.

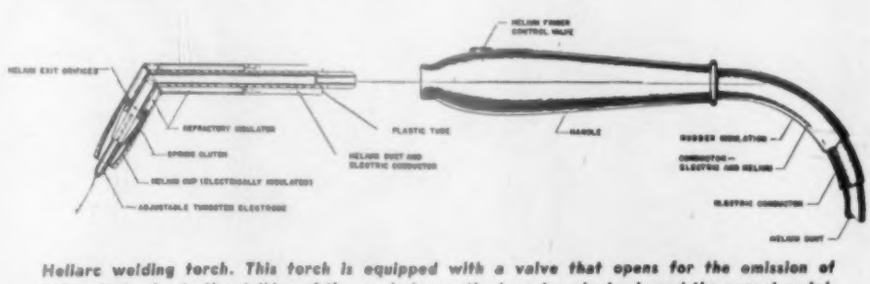
Castings, which are normally solution heat treated for long periods of time, are not subject to this shortcoming. They may be given their standard heat treatment and returned to 90 to 100% efficiency.

Only limited data are available on the fatigue strength of arc welded joints. The data given in Table II for both Krause and R. R. Moore tests show that the weld has almost the same fatigue strength at 10^8 cycles as the original metal. The Krause tests were made on flat sheets with the bead ground flush. The R. R. Moore specimens were machined from welded panels which had been given a double 120 degree vee before welding.

Summary

The Heliarc method of arc welding magnesium alloys has provided an important new tool for the fabrication of these light, strong alloys. The welding may be done over a wide range of currents, speeds and alloys, and the results, from a metallurgical standpoint, are extremely good. Both the strong wrought alloys and the casting alloys may be welded to give tensile strengths exceeding 90% of that of the original metal.

Part Two, dealing with production methods of joining magnesium alloys, will appear in an early issue of THE WELDING ENGINEER.



Heliarc welding torch. This torch is equipped with a valve that opens for the emission of helium just prior to the striking of the arc between the tungsten electrode and the parent metal.

Safe Practices in Wartime

CONSERVATION of materials such as iron and steel and other vital metals is imperative. Plants and workers are asked to conserve their equipment so that it may produce more by operating longer periods. I believe that more and more another conservation movement will develop to large proportions and assume its proper place. This is the conservation of labor by safe practices and methods of working. Every skilled worker can help to conserve our united time and labor by working safely.

We in welding, I am convinced, are more than just an important link in the production chain. Almost everything in the war effort depends upon us. Conservation of our labor, welding labor, will be advanced if each weldor observes seven simple safety rules:

1. Wears proper shoes and clothing.
2. Uses proper protective equipment for the glare of arc or flame.
3. Has adequate ventilation from fumes.
4. Wears goggles at all times.
5. Removes all combustible material from the job.
6. Takes care around loose tools, equipment, cables, hoses, etc.
7. Is aware of his position with respect to others and to his surroundings.

Through long years of experience in car building, and more recently on our work on Government ordnance projects, we have found that these rules do promote safety and conserve labor by creating more productive man-hours.

1. Clothing and Shoes

Whenever a weldor is working around an open flame or an arc, he should wear clothing that will minimize the danger of fires starting. Woolen clothing is always better than cotton because it does not ignite easily. Overalls, jackets, etc., should not be greasy or oily. Leather gloves, sleeves, aprons and jackets can be worn as a protection from sparks, splatter or slag.

In our plants, we are very insistent upon proper clothing. Leather gloves, sleeves, etc., are on sale at cost so that weldors can obtain them easily. Also, safety shoes are a "must" necessity. A weldor, whether in the aircraft division, tank division or shipbuilding division of our company, *must* wear safety shoes. Work generally is speeded up when the number of foot injuries is decreased.

2. Protective Equipment

In welding or cutting, it is important that the eyes be protected from the heat and the glare of the flame or the arc. For this reason, and as a further protection to the skin because of the intensity of the ultraviolet and infrared rays, welding helmets or shields should be worn in arc welding. Properly selected goggles are sufficient for protection from the flame. In both cases, however, the colored lens must be adequate for the job at hand. Valuable information concerning the specifications for eye protection can be obtained from the "National Safety Code for the Protection of the Heads and Eyes of Industrial Workers" issued by the National Bureau of Standards, Washington, D. C.

Welding should be performed in separate rooms or in locations where screening is possible in order to eliminate the danger of eye injuries from reflected or direct rays of the arc to other workers or passers-by. Where many weldors are working, as on a ship section, the individual weldor should show consideration of his fellow workmen when striking an arc. And, as a precaution to protect their eyes, the workmen nearby should shield their faces and eyes adequately whenever an arc is struck.

Official OWI Photo by Palmer

Goggles are necessary to protect the weldor's eyes and should be worn by him at all times—even under the helmet, as this picture shows. With helmets raised, these men still have adequate eye protection.

3. Ventilation

Ventilation is a serious factor in welding. In large open shops or in the outside atmosphere, fumes can dissipate themselves without resulting irritation, but in smaller shops, welding schools or in restricted spaces, such as compartments or holds of a ship, enough ventilation must be installed to insure good visibility and a comfortable working temperature. Usually 100 cfm per operator is sufficient ventilation for most work.

Portable ventilation systems are very useful in ship construction work for local exhaust. For welding galvanized steel, with its resulting zinc fumes, ventilation is almost mandatory. For occasional exposure where adequate ventilation facilities cannot be provided, a proper type of filter

Application of Welding*

By **HENRY A. MATIS**
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respirator that fits under the helmet will give the weldor adequate protection.

4. Goggles

The use of goggles is a very big conservation factor on the safety program. Goggles must be worn by the weldor at all times because they are necessary to protect his eyes. They are valuable protection when removing slag from welds, either before or after welding. Even though the slag will not be removed by a slag hammer, during cooling particles pop up that may enter the eye just as easily as those liberated during a slag cleaning process. Furthermore, chips or particles from a grinding or chipping operation may enter the unprotected eye of a nearby weldor.

We at Pullman demand the wearing of goggles for the men's own protection. Whether on cars, ships or tanks, our weldors wear their goggles continuously. They are worn under the helmet, thus insuring eye protection whenever the helmet is raised or removed from the weldor's head. Eye injury is, consequently, very rare in our plants.

5. Combustible Materials

At a time when it is imperative to maintain full production and to conserve labor, we are conscious of the part that saboteurs and arsonists can play in hindering our effort. We could be a tool in their hands to accomplish their purpose (or we could unintentionally achieve the same thing) if we allow combustible materials near welding arcs or flames. Every small fire is a potential big fire. All of us know too well the lesson that was brought home so forcefully in the disaster of the *Normandie*.

Definite rules must be set up to avoid a stoppage of production from this cause. These rules are:

(a) Do not perform cutting or welding in or near rooms containing flammable vapors or liquids or exposed loose combustible material.

(b) Do not set up welding or cutting near dipping or spraying rooms. Work performed in a hazardous location is not safe work.

(c) If cutting or welding must be done on a floor that is combustible, keep that floor clean and wet it down before starting work. Wooden floors should be covered with metal or noncombustible material.

(d) Place a small hose, chemical extinguisher or fire pails convenient to work that must be performed near wooden structures or near combustible material which cannot be easily removed or protected.

(e) Where combustible material has been exposed to molten metal or hot slag, keep a watchman in the vicinity for at least *half an hour after completion of the work* to make sure that smoldering fires are not started.

(f) Make periodic checks of all hoses, cables, torches, electrode holders, and connections in order to insure tight connection or to prevent overheating.

By following these rules faithfully, fires will be prevented.

6. Loose Tools and Equipment

Many cases of stumbling or falling are due to loose tools, equipment, cables or hoses lying around in disorder. Good housekeeping, orderliness and safety consciousness will eliminate these hazards. Passageways, ladders, openings, ditches, etc., should all be kept clear and free as possible of these items. Cables that have been installed in ducts or suspended overhead will eliminate a hazard that tends to destroy a weldor's conservation efforts to himself, his company, and his country.

7. Weldors' Responsibility

Lastly, a weldor or a worker, on whatever job he may be doing, must be conscious not only of his own safety but of the safety of others working near at hand. Care with tools and material on high places, safety applied on the job all the way through, tends for less lost time. This mental attitude can be initiated at the start if weldors, whether gas or arc, are required to pass tests along safety lines as well as on welding ability.

These seven precautions—proper clothing, protective equipment, ventilation, goggles, fire prevention, elimination of tripping hazards and a regard for others—will help all of us, individually and collectively, to conserve our efforts so that each of our jobs can be done faster and better.

*Presented at the Section on Gas and Electric Welding of the 31st National Safety Congress and Exposition, Chicago, October 28.

Welding helmets with suitable lens and adequate protective clothing should be worn in arc welding to protect the weldor's eyes and skin from the ultraviolet radiation of the arc. Observance of a few simple safety rules (see text) will eliminate the hazard sometimes presented by flying sparks.

Official OWI Photo by Palmer

Thermit Welded Ship Frame C

Castings of any size can be welded together with thermit, and hence stern frames can be assembled from any desired number of separately cast sections. A properly made thermit weld is even stronger than a steel casting of the same cross-section.

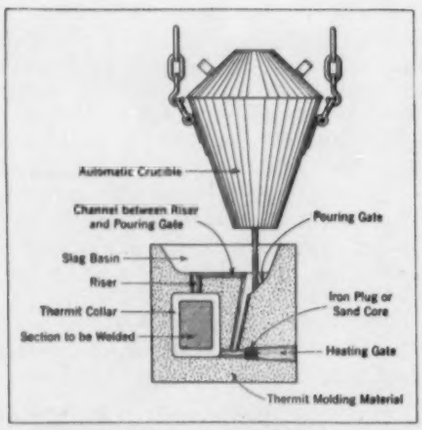


Fig. 1—General arrangement for thermit welding showing relative locations of crucible, mold and the section to be welded.

THE THERMIT WELDING process is now being employed in many shipyards for joining cast stern-frame sections into complete assemblies. More than one hundred merchant vessels built during the past year or now being built have thermit welded stern frames, and the number to be so equipped is much larger. Among considerations which have led to the adoption of thermit welding are its speed and efficiency, the durability of the welds and the fact that it renders unnecessary the use of large, intricate castings with their attendant manufacturing, shipping and handling difficulties.

Because there is no limit to the size of the steel castings that can be welded with thermit, the stern frames can be assembled from any desired number of separately cast sections as determined by casting, shipping and handling facilities. Another advantage is that no machine work is required for the preparation of the ends to be united by this welding process.

The Thermit Reaction

As is well known, thermit is a mechanical mixture of finely divided metallic aluminum and iron oxide in the form of magnetic iron scale. The proportions are, roughly, one lb of aluminum to three lb of iron. This mixture is fired by means of a special ignition powder, composed largely of barium peroxide, which produces a temperature of 2,800 F. A vigorous reaction takes place. The aluminum combines with the oxygen of the iron oxide to form aluminum oxide, leaving metallic iron or, more properly, steel. Thirteen lb of thermit will produce seven lb of steel.

The reaction takes about 30 seconds (regardles of the amount of thermit involved), and it generates intense heat. The very high temperature of 4,959 F which results is approximately twice as hot as ordinary molten steel. Hence it is scarcely surprising that the steel formed is as liquid as water. This liquid steel separates itself entirely from the aluminum oxide, which floats on top in the form of slag.

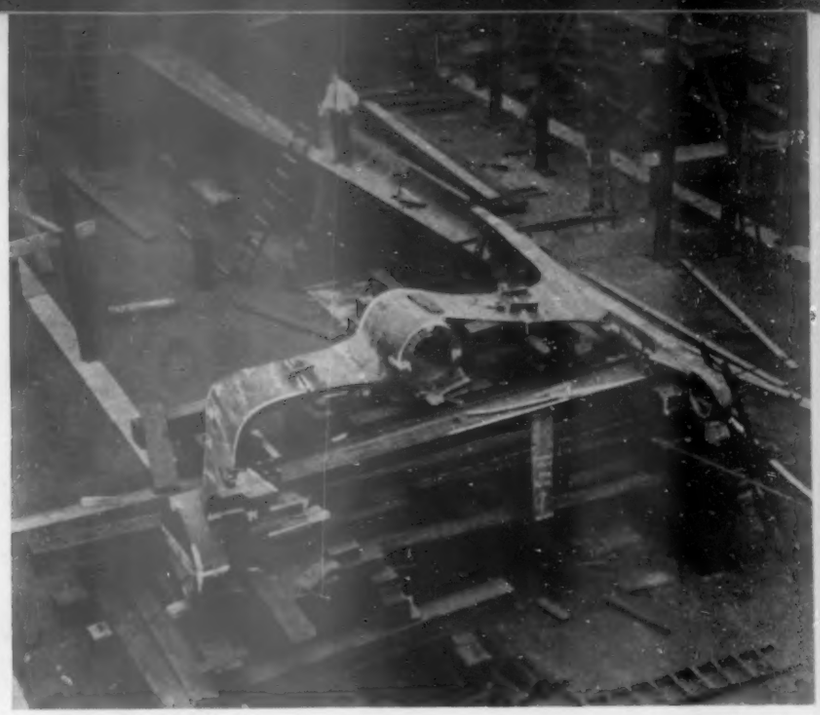
Making a Weld

Fig. 1 shows a cross-section of a typical set-up for making a thermit weld. The highly liquid steel is run between and around the ends of the parts to be welded. When the fluid metal touches solid metal, the latter

Applying the wax patterns, one of the early steps in preparation for a thermit weld. The wax is burned away during preheating, leaving a cavity to be filled by thermit steel.

e Construction

By I. T. PRIESAND
Welding Engineer, American Shipbuilding Co.



Stern frame for a cargo ship. The frame, in three sections, is lined up for welding at the end of the keel on the partially completed hull.

also melts, and the two intermix. On cooling, there is formed a perfect fusion weld, which is dense, sound and stronger than a steel casting of the same cross-section.

One reason for the excellent physical properties of the thermit weld is that the metal completely fills the mold. All air is excluded, thus preventing any deterioration due to the high heat. The molten metal has been completely deoxidized, and it solidifies from the inside towards the outside. As the weld is made in a single operation, only one shrinkage is involved, and local internal stresses do not develop. Thermit welds, therefore, do not require stress relieving.

Thermit Welds for Marine Work

The thermit process has been tested and approved by Lloyd's, the American Bureau of Shipping and other marine inspection bureaus. Though many hundreds of ship repairs have been made with thermit during the past 30 years, not one of these welds is known to have failed.

Several different types of thermit are supplied for various kinds of welding work. That which shipyards are using for stern-frame fabrication is known as forging thermit because it produces a steel with the strength, toughness and ductility of forged steel. The average tensile strength of this weld metal is about 70,000 psi, and its elastic limit is about 36,000 psi.

Fabricating a Stern Frame

Assemblage of the sections of a stern frame for thermit welding may be divided into six steps:

1. *Designing of Castings.* In designing the stern-frame sections for thermit welding, provision should be made for a gap of ½ in. between the ends of each pair of sections. The cross-section of each casting should be solid for several inches from each end, and a clearance of at least 18 in. should be left between each end of a casting and any protuberance that would interfere with the placing of the mold boxes used in making the welds.

2. *Preparing the Sections for Welding.* The sections of the stern frame are mounted on supports to provide necessary clearance and are laid out on a bed plate. The surfaces of the castings are cleaned of casting sand and other foreign matter. The gap between the castings to be welded is widened by cutting a small amount of metal from each end with an oxy-acetylene torch. Though the cut ends are freed from loose scale, they are not cleaned to bright metal.

3. *Applying the Wax Pattern.* This is one of the most interesting aspects of the thermit process. Special pattern wax, warmed to a plastic temperature, is worked into the gap between the ends to be welded. Thermit steel will later take the place of this wax, which is molded to form a smoothly rounded collar. As 25 lb of thermit are needed for every pound of wax in the pattern, the amount of thermit required to make the weld can easily be calculated from the weight of the wax used. The latter weight is found simply by weighing the wax supply before and after the pattern is made.

After the wax patterns for the collars of weld metal have been applied, mold boxes are placed around the frame at the points to be welded. The mold sand is tightly packed by ramming, and then preheating, as shown here, is begun.

Fresh out of the mold, a thermit weld looks like this before the gates and risers have been removed.

Table I. Data on the Assembly of a C-1-A Stern Frame

Weld	Gap (In.)	Wax (Lb)	Molding Material (Bbl)	Preheating (Hr)	Thermit (Lb)
A	1¾—1½	38	8	9	800
D	1½—1¼	35	9	8½	750
B	1¾—1½	38	7½	8	800
C	1½—1¼	18	5	7	375
TOTALS		129	29½		2,725

Sequence of welds: A, upper rudder post and first section; D, upper propeller post and second section; B and C, welding the two assemblies.

Man-Hours: Total time of four-man crew, making welds and removing gates and risers, 66 hr per man.

4. Constructing the Mold. After the wax pattern has hardened, a mold box, specially designed to enclose the parts to be welded, is placed in position. The construction of a typical mold is shown in Fig. 1.

5. Preheating. The parts to be welded are preheated by means of a specially designed preheater. This operation takes from six to nine hours, depending upon the size of castings and mold. Preheating dries out the mold and burns out the wax pattern, leaving a cavity to be occupied by the thermit steel. It also brings the ends to be welded to a good red heat.

6. Preparing the Thermit Crucible. While the parts are being preheated, the thermit crucible is prepared. Crucibles are made in several different capacities to suit welds of various sizes. After one has been used four or five times, its lining must be renewed.

To prepare a crucible, it is first warmed to free it from moisture and then plugged and filled with thermit. Toward the end of the preheating period, the crucible is placed so that its contents will run down into the mold. When the weld is ready for pouring, the thermit in the crucible is leveled off flat, and two full-diameter cross furrows are formed on the surface. These are filled with ignition powder, and several match heads are imbedded in the powder at the point where the furrows intersect.

Firing and Tapping

When everything is in readiness, the operator fires the ignition powder. The reaction takes less than a minute. When it is over, the tapping pin at the bottom of the crucible is forced upward. The molten steel then runs into the mold, and the slag fills the slag basin.

The weld is allowed to cool slowly until the weld metal is at a temperature of not over 300 or 400 F. The mold can now be stripped off, and the gates and risers cut off.

The weld should show a sound, well formed collar. If sand inclusions or other defects are noted, the collar should be chipped away locally to determine whether or not the defects are superficial. If desired, the entire collar may be removed as it is not needed for reinforcement.

Training Thermit Weldors

The rating bureaus usually require thermit ship repairs to be carried out by (or under the supervision of) expert operators from the Metal & Thermit Corp. The restriction, however, does not apply to the thermit welding of stern-frame castings as a routine operation in shipbuilding. This work can be done by men without special experience or qualifications, after a few days of special training.

In each yard adopting the process, a crew of regular workers, consisting of a head man and two or three helpers, is assigned to the work. The crew is trained by specialists supplied by the makers of thermit, who weld

Gates and risers have been cut away, and the completed stern frame is now ready for installation.

The completed frame is lifted to an upright position for fastening to the keel.

the first frame. Succeeding frames are welded by the regular workers under supervision of the thermit specialists. After welding three or four frames, the crew is usually competent to carry on without further supervision.

Materials and Equipment

Table I gives the principal data in the actual assembly of a C-1-A stern frame cast in four sections by the thermit process. Total time required for a four man crew to make the welds and remove the gates and risers was 66 hr per man. Material costs totaled $1,020.10. There were required:

2,725 lb of thermit @ 30c	$ 817.50
129 lb of pattern wax @ 25c	32.25
29½ bbl of molding material @ $5.50	162.25
Ignition powder	8.10
TOTAL	$1,020.10

Certain special molding tools needed for carrying out thermit welding are listed in Table II. No other facilities, except those found in practically every shipyard, are required.

Table II. Equipment for Thermit Welding

Special equipment supplied by the makers of thermit:

2 preheaters @ $85.00	$170.00
2 No. 12 crucibles @ $240.00	480.00
2 No. 10 crucibles @ $80.00	160.00
1 pneumatic bench rammer	90.00
2 3-section hand rammers @ $6.75	13.50
1 molder's lifter	.90
2 oval spoon slicks @ 85c	1.70
2 wax knives @ 75c	1.50
2 molder's trowels @ $1.20	2.40
TOTAL	$920.00

Cost of relining crucibles* after 4 or 5 uses:

No. 12	$112.00
No. 10	48.50

**Used crucibles are usually promptly exchanged by the makers for relined crucibles, thus saving time.*

Equipment to be supplied by the shipyard:

Steel for mold boxes, crucible supports, etc.; oxy-acetylene cutting equipment and gases; water-white kerosene for preheating; compressed air.

Thermit welding has long been considered a repair tool but now is becoming, rightfully, a production tool in shipyards. It affords a speedy and highly satisfactory means of joining similar ferrous materials having heavy cross-sections. In the welded fabrication of stern-frame castings, an interesting feature is the manner in which the frame to be welded is lined up on its side at the end of the keel of the unfinished hull. After welding, the frame is put into place for fastening to the keel by simply lifting it to an upright position.

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Welded Manhole Covers

By **H. C. ELLIOTT**
Superintendent of Maintenance,
Mississippi Valley Barge Line Co.,
Cincinnati

CONVENTIONAL manhole covers for barges and boats are made of steel castings. A rim is riveted or welded to the deck, and the cover, with a rubber gasket, is then attached to the rim. This manhole cannot be conveniently mounted flush with the deck.

On a contract for 45 large barges, each requiring 22 manhole covers, the suggestion was made that all covers be of welded construction.

The cast steel covers cost $32.70 each; the welded covers $10.80 each. Thus welded design saved $21.90 on each cover, $481.80 per boat, and $21,681 on the entire contract of 45 boats. In addition, the welded covers were stronger and more attractive than those of cast steel and could also be mounted flush with the deck.

The center and right illustrations below show the design of the welded covers. The cover top was flame-cut from $\frac{5}{16}$ in. plate. To this was welded a 1 by 1¼ in. angle rolled from ¼ in. plate. Five spring steel lock springs radiated from the hub, which was cast from malleable iron and drilled for pins.

Photos courtesy of Hobart Brothers Co.

On the left is the old type of cast steel manhole cover, closed. A top view of one of the new welded covers is shown in the center. At the right is the underside of the new-type cover with springs in the locked or "out" position.

The Spot Welding of N-

★ Part Two—Thin gauge high tensile steels are difficult to spot weld because of a high cooling rate that causes a brittle weld structure. By a new method, a spot welder is used to post heat treat the brittle weld zone to obtain a structure of far greater toughness and ductility.

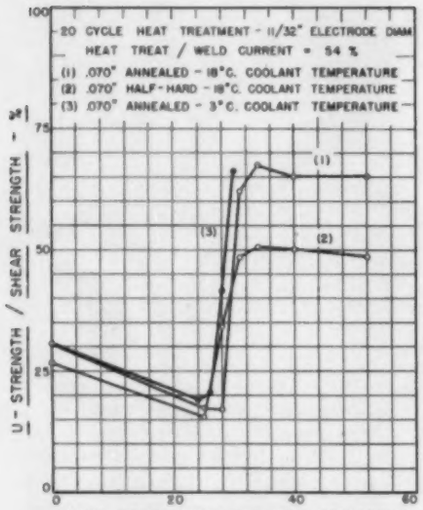

20 CYCLE HEAT TREATMENT - 11/32" ELECTRODE DIAM
HEAT TREAT / WELD CURRENT = 54 %
(1) .070" ANNEALED - 18°C. COOLANT TEMPERATURE
(2) .070" HALF-HARD - 18°C. COOLANT TEMPERATURE
(3) .070" ANNEALED - 3°C. COOLANT TEMPERATURE
U - STRENGTH / SHEAR STRENGTH - %
CYCLES BETWEEN WELD & HEAT TREATMENT

Fig. 6—Effect of the interval between weld and heat treatment upon U-strength to shear strength ratio (a measure of weld toughness). For the 0.070 in. material, the optimum value of this "critical interval" was found at about 32 cycles.

In the course of an investigation carried out at the Welding Research Laboratory of Rensselaer Polytechnic Institute by Mr. Schroder and Dr. W. F. Hess, a very successful method was found for spot welding N-A-X high tensile steel. Briefly, this method consists of (1) making the weld in a single pulse of as few cycles as necessary, (2) allowing a very definite and "critical" interval for the weld to cool and (3) drawing or tempering the weld zone by a second "heat-treating" pulse. Welds made by this method were found to have structures softer, more ductile and of far greater toughness than the weld structures obtained by previous methods of spot welding these thin gauges of deep hardening steels.

Part 1 of this article (November, 1942, issue of THE WELDING ENGINEER*) discussed the results obtained with material of 0.040 in. thickness. The present and concluding installment will be largely confined to the investigation of the 0.070 in. material.*

THE WELDED structure with no subsequent heat treatment is hard and brittle. The hardness, as measured by the Vickers method, is in the range of 420-440 V.P.N. This is certainly hard for 0.14 carbon steel. This structure has been termed martensite throughout this investigation, although the microscope does not show it to be exactly the same in appearance as typical as-quenched martensite of ordinary heat-treating practice. The difference can possibly be attributed to the fact that this weld structure has been quenched from the molten state at a rate which is very much higher than that associated with ordinary heat treatment and under a pressure of 1,500 atmospheres.

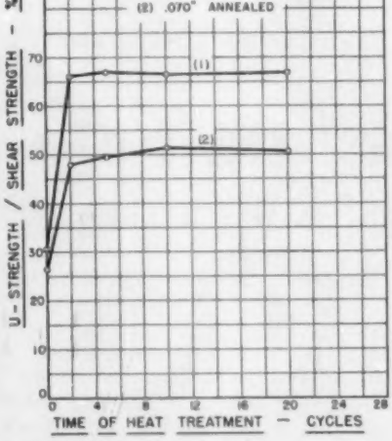

34 CYCLES BETWEEN WELD & HEAT TREATMENT
11/32" ELECTRODE DIAM.
(1) .070" HALF-HARD
(2) .070" ANNEALED
U - STRENGTH / SHEAR STRENGTH - %
TIME OF HEAT TREATMENT - CYCLES

Fig. 7—Effects of heat-treating current of various cycles upon weld toughness. The interval between weld and heat treatment was held constant at 34 cycles.

The microstructures of specimens welded and subsequently heat treated in the welding machine are more clearly defined, exhibit faster and darker etching characteristics and resemble closely the quenched and drawn structures which are obtained from ordinary heat-treating practice with this type of steel. The as-welded structure required an etching time of from two to three minutes with a 5% picral solution, whereas the quenched and drawn structure required an etching time of one minute with the same solution.

0.070 In. Material

The investigation of the 0.070 in. material has confirmed the general results obtained with regard to the 0.040 in. material. Of course the electrode size, pressure, welding time, time interval between weld and heat treatment, time of heat treatment, welding amperage and heat-treating amperage may all be expected to vary with variation in material thickness.

For the 0.070 in. material, it was found that the critical minimum time interval which must be allowed between weld and heat treatment is about 32 cycles. It was again found that the ratio of U-strength to shear strength, for welds which were heat treated after a time interval of less than 32 cycles, was lower than the ratio obtained for welds receiving no heat treatment at all. The explanation for this is evidenced by a corre-

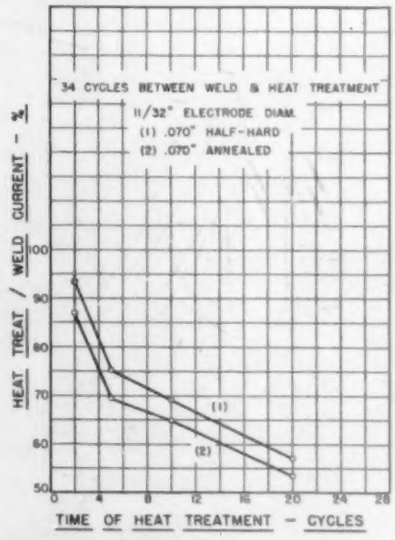

34 CYCLES BETWEEN WELD & HEAT TREATMENT
11/32" ELECTRODE DIAM.
(1) .070" HALF-HARD
(2) .070" ANNEALED
HEAT TREAT / WELD CURRENT - %
TIME OF HEAT TREATMENT - CYCLES

Fig. 8—The heat-treating cycles of Fig. 9, plotted against heat-treating currents (expressed as percentages of welding current).

# of N-A-X High Tensile Steel*

By **C. R. SCHRODER**

Research Metallurgist, Great Lakes Steel Corp., Detroit

lation of the hardness surveys across the weld structures, including the heat-affected zones and the parent metals.

Hardness Gradients

Photoelastic studies have shown that, in the U-type tensile testing of a spot weld, the maximum stress concentration is located at the heat zone to weld junction. For spot welds made by ordinary methods in plain low carbon steel, there is very little hardness gradient between weld and heat zone, and between the heat zone and parent metal. The entire structure is comparatively soft and ductile. These welds in plain low carbon steels have high U-strength to shear strength ratios.

For welds made without subsequent heat treatment in high tensile and hardenable steels, there exists a steep hardness gradient from parent metal to heat zone with little hardness gradient from heat zone to weld. The weld and heat zones may be very hard and brittle but have little hardness gradient across their junction. They will exhibit comparatively low U-strength to shear strength ratios. Much of the stress, however, is probably concentrated at the parent metal to heat zone junction as a result of the steep hardness gradient across this junction. This means that the stress concentration is divided between the parent metal to heat zone junction and the heat zone to weld junction. The first stress concentration is a result of hardness gradient, and the second stress concentration is a result of the notch effect inherent to this U-type of normal test.

Effects of Heat Treatment

For welds in high tensile and hardenable steels made with subsequent heat treatment in which the time interval between weld and heat treatment has not been long enough, the heat zone is greatly softened and the weld remains very hard. This means that the entire stress concentration resulting from notch effect and hardness gradient acts on the heat zone to weld junction. The latter is inherently sensitive to normal stress since it is the origin of the ingrowing dendrites. Thus a weld heat treated without sufficient time interval between weld and heat treatment will have extremely low resistance to stresses which are normal to the welded surface and will snap apart in a very brittle fashion and at low loads in the U-type tensile test. These welds exhibit even lower ratios of U-strength to shear strength than welds properly made but without subsequent heat treatment.

For welds properly made and heat treated after sufficient time interval between weld and heat treatment, both the heat zone and weld have been softened with little or no hardness gradient across their junction. These welds exhibit a ratio of U-strength to shear strength which is double the value obtained for welds given no subsequent heat treatment.

If the heat treatment rehardens the center of the weld, it will not appreciably lower the U-strength of the weld provided the rehardened area does not approach the heat zone to weld junction. This junction is the all important area, and heat treatment should be directed at softening the heat zone and the first 0.02 to 0.04 in. of the outside of the weld area, giving little or no hardness gradient across this junction.

As above stated, the critical time interval between weld and heat treatment was found to be 32 cycles for the 0.070 in. material, as compared with 12 cycles for the 0.040 in. material. The difference is considerable; however, the values are in fair agreement with mathematical prediction that the cooling rate of spot welds varies inversely as the square of the thickness.

Refrigerated Coolants

In working with the 0.070 in. material, a study was made of the effect of refrigerated coolants with respect to lowering the time interval required between weld and heat treatment. During the entire investigation, the coolant temperature had been about 18 C. Lowering of this coolant temperature to 3 C decreased the time interval by only 2-3 cycles. This means that coolants would have to be refrigerated to very low temperatures in order to result in an appreciable saving in time, and the sometimes ill effects of water condensation and frosting on the electrode tips, plus the cost of refrigeration, would have to be balanced against the economics of a possible increase in production speed.

*Presented at the annual meeting, AWS, Cleveland, Oct. 12 to 15, 1942.

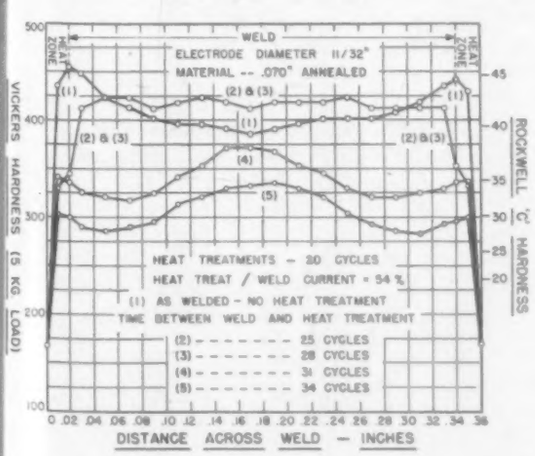
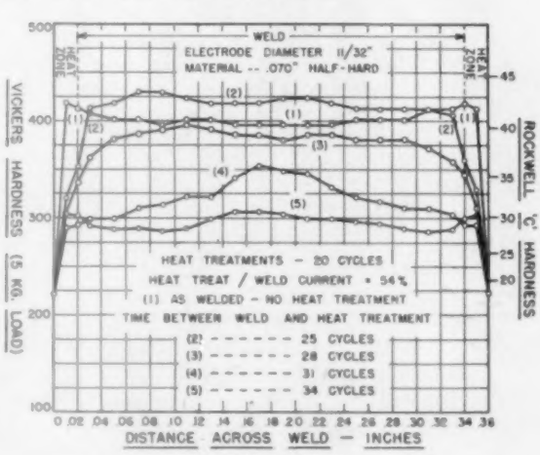

WELD
HEAT ZONE
HEAT ZONE
ELECTRODE DIAMETER 11/32"
MATERIAL -- .070" ANNEALED
(2) & (3)
(1)
(4)
(5)
HEAT TREATMENTS - 20 CYCLES
HEAT TREAT / WELD CURRENT = 54 %
(1) AS WELDED - NO HEAT TREATMENT
TIME BETWEEN WELD AND HEAT TREATMENT
(2) - - - - - - - - 25 CYCLES
(3) - - - - - - - - 28 CYCLES
(4) - - - - - - - - 31 CYCLES
(5) - - - - - - - - 34 CYCLES
VICKERS HARDNESS (5 KG. LOAD)
ROCKWELL 'C' HARDNESS
DISTANCE ACROSS WELD - INCHES

Fig. 9 (left)—Effect of 20 cycles of heat-treating current upon the hardness across the weld zone for 0.070 in. annealed sheets. Curve 1 represents a weld not heat treated; the other curves are of heat treated welds which had varying intervals between weld and heat treatment.

Fig. 10 (right)—Effect of 20 cycles of heat-treating current upon the hardness across the weld zone for 0.070 in. half-hard sheets. Curve 1 represents a weld not heat treated; the other curves are of heat-treated welds which had varying intervals between weld and heat treatment.


WELD
HEAT ZONE
HEAT ZONE
ELECTRODE DIAMETER 11/32"
MATERIAL -- .070" HALF-HARD
(1)
(2)
(3)
(4)
(5)
HEAT TREATMENTS - 20 CYCLES
HEAT TREAT / WELD CURRENT = 54 %
(1) AS WELDED - NO HEAT TREATMENT
TIME BETWEEN WELD AND HEAT TREATMENT
(2) - - - - - - 25 CYCLES
(3) - - - - - - 28 CYCLES
(4) - - - - - - 31 CYCLES
(5) - - - - - - 34 CYCLES
VICKERS HARDNESS (5 KG. LOAD)
ROCKWELL 'C' HARDNESS
DISTANCE ACROSS WELD - INCHES

The optimum spot diameter for the 0.070 in. material was found to be about 0.310 to 0.320 in. As in the case of the 0.040 in. material, it was found that the advantages of heat treatment could be obtained in a few cycles of heat-treating time. The optimum time for heat treatment, with respect to current flexibility and sufficient weld area softening, was found to be about 8 cycles for the 0.070 in. material. Optimum welding time for this material was also 8 cycles.

Summary and Conclusions

1. Remarkable improvement in toughness of the spot welds in hardenable steels is possible by brief heat treatment in the spot-welding machine following welding. This appears to open a new field of spot welding in those steels in which spot welds are ordinarily hard and brittle.

2. The mechanism of the toughening consists of allowing a drastic quench to martensite, followed immediately by a high draw at a temperature just below the critical.

3. A time of from 2-5 cycles is sufficient to secure the maximum benefit of post heat treatment in the gauges of steel in this investigation.

4. Sufficient time must be allowed for the steel to cool to the martensite-forming temperature as otherwise the reheating accomplishes nothing. In order to reduce the time required for cooling, the weld should be made in the shortest possible time. This is due to the fact that the more rapidly the weld is heated and made, the less total heat is required and consequently the more rapid the cooling. This will permit reasonable total weld plus heat treatment time and thus not tend to limit production speeds.

5. The heat-treating current must be carefully adjusted to raise the temperature as high as possible without reaching the critical transformation temperature.

6. The chisel test is a practical shop method of determining the proper magnitude of heat-treating current. Hardness tests at the center of weld cross-sections for a series of welds with progressive variations in heat-treating current will select the best value with greater certainty.

7. With respect to the 0.070 in. material, lowering the coolant temperature from 18 to 3 C will reduce the time interval required between weld and heat treatment by only 2-3 cycles—from 32 cycles to about 30 cycles.

8. The general procedure and method used in this investigation could probably be used to greatly improve spot weld quality in all types of low alloy high tensile, high carbon and deep hardening alloy steels.

The End

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New Stud Welding Process

IN MANY shipyards, the fastening of wooden planks to metal decks has been greatly speeded up by means of a newly designed arc welding gun. This device welds studs through the planks to the deck plating below, entirely eliminating the necessity for drilling holes through the metal deck. Hence, the metal plating remains watertight, with no danger of seepage through loosened bolts, and the planking can be laid without interference with the wiring, ducts, fittings, etc. on the underside of the deck plates.

Before the planking has been placed in position, holes are drilled through the wood; each hole is counterbored in order to obtain a shoulder for supporting the stud nut. The stud will fit snugly into the lower part of the hole.

A lava ferrule is dropped into the lower hole. This serves as a cup to hold a measured spoon of granulated arc inducing material. The ferrule also shields the wood planking and the stud threads from the heat and flare of the arc and acts as a protective medium (similar to the coating of a shielded-arc type electrode) for the molten metal.

The granulated metal material serves a dual purpose: to establish the arc and to improve the quality of the weld metal. The welding gun combines arc welding with impact or forge welding, driving the stud into a molten crater in the deck plating.

This newly developed welding gun is not a spot welder but an arc welder. Duration of the arc is controlled automatically by an electric timer in the control cabinet, shown at left. Two perfect welds may thus be produced every minute.

Photo by Hollup Corp. Div. of National Cylinder Gas. Co.

Use of this equipment does not require skill nor long training on the part of the operator, who simply loads the gun with a stud, cocks it and presses the trigger. The latter act sets in motion an automatically controlled welding cycle. The current flows for approximately a third of a second and is then interrupted while the gun instantaneously plunges the stud into the molten crater which has been formed by the arc. The gun is now "dead" and may be withdrawn without danger of accidental arcs. The entire welding operation requires less than 30 seconds.

The welded stud is now ready for nut assembly. A shipwright follows the weldor to apply a special nut fitted with a cotton grommet and metal washer. The nut is tightened with a forked T-wrench, and the hole sealed by a wooden plug, burying stud and nut below the surface of the planking.

Although designed primarily for ship deck work, this equipment may also be used for other applications which call for the end-welding of steel sections. Round, square, hexagonal, oval, etc. bars, from ⅛ to ½ in., can be welded to plates of different thicknesses, inasmuch as collets are available to handle a variety of shapes, either plain or threaded.

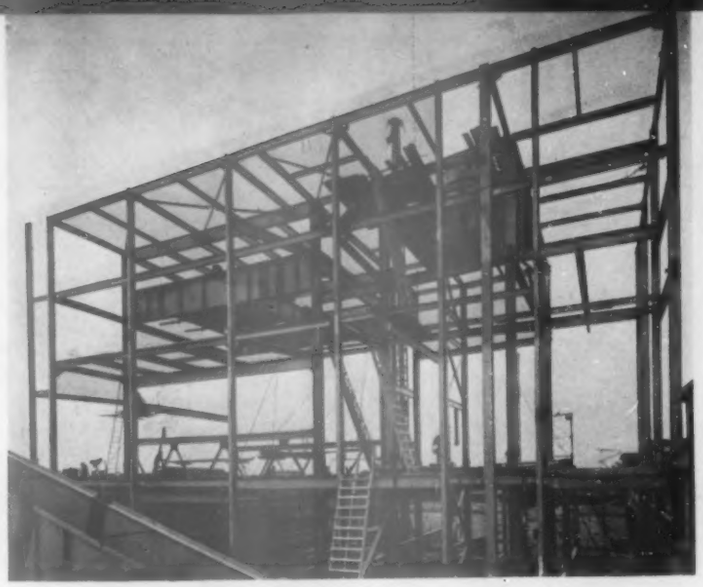


Fig. 1—New multi-story power company switch house under construction. Decision was reached at the last minute to change over from riveted to welded joint construction.

Welded Building Construction

Records indicate that design and erection considerations are important factors in structural steel welding costs. Weldors average 32 in. of ⅜ in. fillet weld per hour.

IN PLANNING a new 60-cycle switch house, the engineering department of a midwestern power company decided upon a riveted structure. Designs for the multi-story building were made accordingly. Just prior to the award of the general contract, however, it was decided that all rivets should be replaced by welded connections. Hence the contract was let for a welded structure.

Among the factors which influenced this second decision may be mentioned the saving in time, the elimination of the noise of riveting (which might cause serious dislocations of business in adjacent buildings) and the fact that welded construction may be added to an existing structure without expensive preliminary work. In addition to these general advantages, the power company, which has a continuous construction program, was desirous of obtaining accurate information on the costs, power requirements, welding time, etc., involved in welding structural steel.

Erection Seats

The planning of a welded structure must always involve provision for some satisfactory means of holding the members together and aligning them for welding. For placement of the horizontal beams on the vertical columns, it was decided to use Saxe erection seats (welded on the columns prior to erection), into which fitted the patented Saxe clips (welded on beams). This construction necessitated shop welding work at costs running approximately $6 to $8 per ton before the field work could be started. These costs, however, were comparable to the shop work required on the usual riveted job.

The use of these patented seats and clips required slightly more work for the shop layout man but eliminated the necessity for templates and patterns and for a fitting-up crew in the shop. Moreover, one weldor and his helper took the place of a riveting gang of four men in the shop. As no further information is available on the shop fabrication methods, the balance of this article will be concerned entirely with the field erection of 157 tons of structural steel.

All of the girders and columns were delivered to the job by truck, and the erection work was done by means of a crawler type crane. After erection had progressed to the point where the crane's extended boom could no longer reach the higher levels (fourth floor and a portion of the roof), the crane was moved from the basement to the ground level in order to set the fourth floor and the balance of the roof. A final 20 tons of roof steel had to be set by a gin pole with a hand crab.

Steel Alignment

The type of connection used on this job, the Saxe erection seat, presented the contractor with a new problem in plumbing the vertical columns and lining up the horizontal members. Considerably more cable bracing was needed throughout the structure than would normally be employed for a similar riveted job. A change of cable guys was made when it was found that only one tier could be plumbed at a time. As soon as each tier was plumbed, all members were tack-welded to hold the established line. After welding, a check made on the perpendiculars showed that the structure was plumb within the required limits.

Weldors and Welders

The welding crew consisted of a foreman, four qualified weldors and three ironworkers' helpers. Two single operator D-C arc welders rated at 300 amp and two rated at 250 amp were employed. The weldors, theoretically at least, lost no time in moving from connection to connection as the helpers had the scaffolds set up in advance. Helpers also cleaned the welds with a chemical cleaning solution in order that a satisfactory painting job might be obtained.

The weldors made good time, averaging 32 in. of double pass ⅜ in. fillet weld per hr. The second pass was necessary because the largest fillet that most structural specifications will permit to be deposited in a single pass is $\frac{5}{16}$ in. Fillet welds were the most common on this job, as indeed they are generally in structural steel welding.

Probably at least 75% of the welds employed today for the fabrication of steel structures will be found to be of the fillet type. This is because

the fillet-welded lap joint, though not so strong as the butt welded joint, offers several important advantages for building construction. Among these advantages, the lap joint permits making allowances more readily for inexactly cut lengths; it requires no edge preparation, and the overlapping members are easily held in position for welding by simple equipment of universal adaptability such as clamps.

All-Position Electrodes

AWS E-6010 $\frac{5}{32}$ in. electrodes were used throughout this job. This type of electrode is a D-C reverse polarity rod suited to welding in all positions. In the "as-welded" condition, the deposited weld metal has a minimum tensile strength of 65,000 psi and 22% minimum elongation in 2 in.

The all-position electrode of this class has many desirable characteristics such as relatively easy manipulation for vertical and overhead welds as well as good contour and appearance of weld deposits made in all positions. For flat or horizontal welding only, however, the E-6010 does not offer so many advantages as do the E-6020 and E-6030 electrodes.

Construction Details

The accompanying pictures portray construction details of this job far more clearly than words could express them. Fig. 1 is a general view of the building showing construction progress, while the other pictures give detailed close-ups of various welded connections.

A typical column base is shown in Fig. 2. This was a 2½ in. plate suitable to provide good seating for the wide flange column supported. The base was grouted into a concrete foundation, after which the column was erected. The feet were 4 by 4 by ⅜ in. angles which were bolted

Fig. 2—Typical column base, a 2½ in. steel plate, grouted into concrete foundation. Angle feet were bolted to the base and welded to the 10 in. wide flange column.

to the base plate and welded to each flange of the column. For this particular application, a ¼ in. 30 deg fillet weld was used. The columns, in most cases, were 10 in. wide flange beams.

Column Connection

One of the major reasons for the use of welding on this job was the ease with which a welded structure may be attached to an existing structure. In Fig. 3 is shown the manner in which a 24 in. wide flange beam was welded to an old column. Note how the inner flange of the old column was extended by the use of two 4 by 4 in. angles so that the load would be equally distributed on the column. While bolts were used for temporary erecting purposes, the load, it should be noted, is transmitted by intermittent fillet welds.

Gusset plates were frequently used where several members came together to form a common joint. An example of this is shown in Fig. 4. In this illustration may be seen the diagonal member of a truss which was brought into a column at a point common to the two horizontal channels which, in this case, were used as a floor beam. This gusset was placed between the two channels to form a spacer while at the same time offering an excellent means of fastening these common members to the column.

In Fig. 5 may be seen most of the welded connection methods that were employed on this building job. Note how the lap plates were cut at an angle.

Fig. 6 is noteworthy for many reasons. The photograph shows a 10 in. 60-lb wide flange column, two 8 in. 17-lb wide flange beams, a 24 in. 74-lb wide flange beam and a 10 in. 23-lb wide flange beam framing into the web of an 8 in. beam. Another 8 in. beam likewise frames into the web of the 24 in. beam. The weld on this 8 in. beam is on one side only.

Poor Fit-up

The 8 in. beam marked "East" was erected in the field despite the fact that insufficient consideration had been given to this construction detail. It should be noted that the clip and angle placement is poor. In order to make the connection, it was necessary to cut away part of the lower flange of this beam. In the design of welded structures, conditions similar to this should always be considered and avoided if the best advantage is to be obtained from the design principles involved and materials used.

Fig. 3 (left)—Connecting a new beam to an old column. The angles extending the inner flange of the column were bolted for temporary erecting purposes, but the load is taken by the intermittent fillet welds shown.

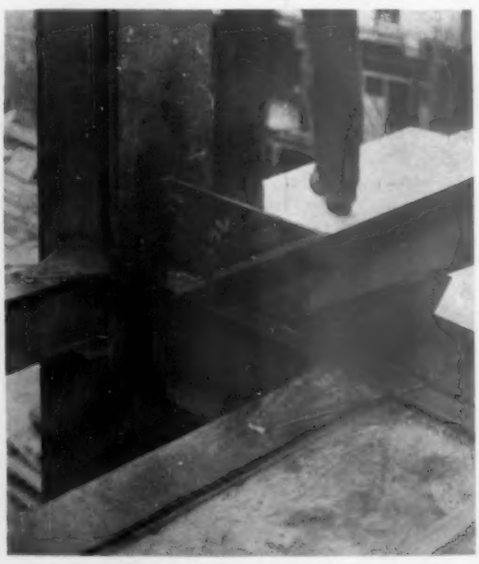


Fig. 4 (right)—Joining several members which came together at a common point. Note use of gusset plates between the two channels forming a floor beam.

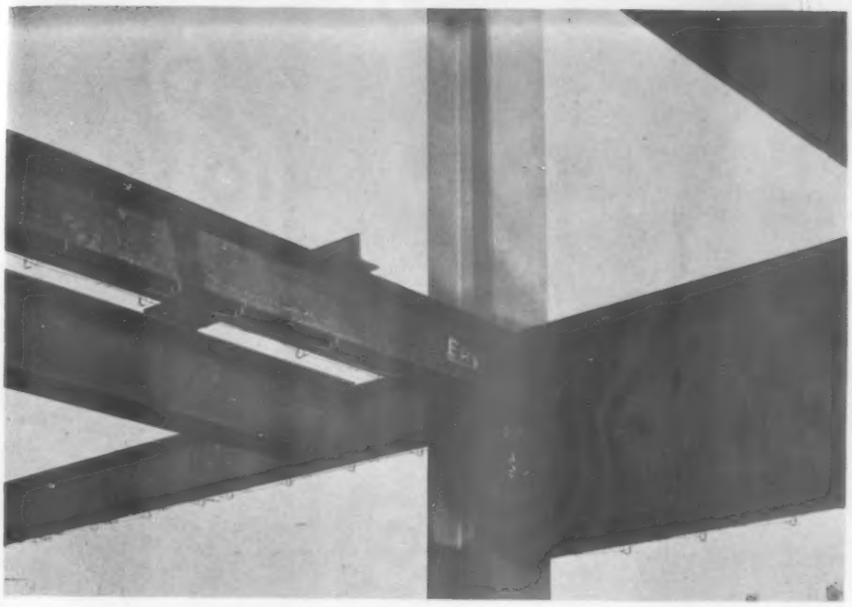


Fig. 6—Framing wide flange beams of different sizes. The beam marked "East" has poor clip and angle placement because of improper design considerations which could not be overcome during erection.

Proper fit-up greatly reduces the cost of welded fabrication. Conversely, poor fit-up will increase the cost in many ways. For example, the volume of weld metal in a fillet increases as the square of its size. Thus if the fillet size must be doubled because of a poor fit-up that increases the space between parts being joined, four times as much metal must be deposited. Nor is this the whole story. The weldor must take more time on this particular joint, and his efficiency is consequently lowered. Furthermore, the excessively large amount of weld metal which must be deposited may introduce heat distortion problems.

Beam Framing

Let us now return our attention to the beam framing problems exemplified by Figs. 6 and 7. The design load conditions and the location of machinery in this building made it necessary to reinforce the floor structure at certain points. This necessitated the framing of beams into one another. In some cases it was necessary to connect a deep section beam to a shallow beam, as is shown to the left of the column in Fig. 6.

So that the beams would have top flanges flush, it was necessary to cut away the lower flange and a portion of the web of the 10 in. 23-lb wide flange beam. Only in this way could the beam be fastened conveniently to the 8 in. beam running between the columns.

The reverse of this situation, that is the fastening of a small beam to a larger one, is shown in Fig. 7. In this case, the upper flange has been removed to provide a flush fit for the top flanges of the two beams, while the lower flange has been cut away to facilitate welding.

Construction Difficulties

Engineering studies made upon completion of the job indicated that the overall cost of welding and erection might have been reduced if the structure had been plumbed tier by tier, as is the usual practice, instead of waiting until the steel was

Fig. 5—Most of the connection methods employed on this structural steel welding job may be found in this picture.

Table I. Erection and Field Welding Data*

Time Required	Hours	Percent	
Unloading	42	3.5%	
Erecting	565	46.5%	Erection 60%
Aligning	123	10 %	
Welding	487	40 %	Welding 40%
Total	1,217		

Costs

(a) **Erection**

Foreman—130 hours @ $2.37 ($1.95 plus 22% insurance, etc.)	$ 308.10	
Timekeeper—2 weeks @ $50.00 per week, estimated	100.00	
Ironworkers—600 hours @ $2.07 ($1.70 plus 22%)	1,242.00	
Crane with operator—9 days @ $50.00 per day	450.00	
	$2,100.10	
Cost based on $2,100.10 plus 30% (estimated) for overhead and profit	$2,730.30	
Average cost per ton		**$17.40**

(b) **Welding**

Foreman—80 hours @ $2.37 ($1.95 plus 22%)	$ 189.60	
Ironworkers—407 hours @ $2.07 ($1.70 plus 22%)	842.50	
Welding rod—400 lb. @ $0.10 per pound	40.00	
Power, 1,200 kw-hr. @ $0.07 per kw-hr. (maximum rate)	84.00	
Hooking up equipment—estimated	200.00	
Welding machine use—229 hrs. @ $1.20 per hour	274.80	
	$1,630.90	
Cost based on $1,630.90 plus 30% (estimated) for overhead and profit	$2,120.17	
Average cost per ton		**$13.50**
Total average cost per ton		**$30.90**

*Based on 157 tons of steel for the main structure.

Fig. 7—Framing a beam into another beam of deeper section. The upper flange has been removed to provide a flush fit for the top flanges of the two beams.

almost completely erected. A delay in the erection of the roof steel (in order to expedite the progress of concrete construction) also tended to increase cost. When erection of the roof steel was resumed, some of the steel had been stored outside the building. It was necessary to move these beams to the first floor and raise them into position, all of this necessitating considerable handling by hand. Some of the roof members had not yet been delivered at that time, so the job incurred still further cost-increasing delays. Because of the small amount of steel involved, these late roof members had to be placed by a gin pole with a hand crab; progress, consequently, was slow.

Cost Data

Pertinent erection and field welding data based on 157 tons of steel for the main structure are given in Table I. The total average cost per ton, $30.90, is somewhat more than the usual cost-per-ton figure for riveted steel erection of this type. Some of this increased erection cost may be attributed to inexperience in using the erection seats and, as previously explained, to difficulties in aligning the structure and to the erection cost of the 20 tons of roof steel which had to be set by gin pole. The cost of the steel erected by gin pole was approximately $28 per ton, and this increased the job unit price proportionately.

A record of lineal feet and inches of welded completed and the time required for welding (on a total elapsed time basis) was maintained for each weldor. Table II tabulates the work accomplished by each of the four weldors on successive working days. The average welding speed was 2.67 ft per hr. Weldor A averaged 2.87 ft per hr, Weldor B 2.75 ft, Weldor C 2.76 ft and Weldor D 2.18 ft per hr. Weldor D's average is 18% under the overall average, indicating that this gentleman is perhaps traveling in "too fast" company. None of the other individual averages differs from the overall average by as much as 8%.

Current Consumption

Daily meter readings were also made to check the amount of power that was used for welding. In Table III is an interesting comparison of energy consumption in kw-hr with the welding footage completed on successive working days. For accomplishing 610 ft 2½ in. of double pass fillet welding, 1,200 kw-hr were required—an average consumption of 1.96 kw-hr per welded foot. The total welding time is given in this table as 228 hr, 10 min, and the average welding speed is 2.67 ft (64 in. of bead) per hr.

It is also interesting to note that in this structure there were 2.5 joints per ton of steel, with approximately 3.95 ft of welding footage per ton of steel.

Table II. Weldors' Work Sheet

Weldor A Footage	Weldor A Hours	Weldor B Footage	Weldor B Hours	Weldor C Footage	Weldor C Hours	Weldor D Footage	Weldor D Hours
7′ 2 ″	1:50						
21′ 3 ″	8:00						
14′ ½″	4:00	20′ 4½″	7:00	18′ 7½″	6:50	10′ 7″	5:45
24′ 3 ″	8:00	8′ 9 ″	3:00	15′ 8 ″	8:00	10′ 11″	7:00
28′ 9 ″	8:00	19′ 8 ″	4:30	4′ 9 ″	1:00	22′ 2″	8:00
13′ 1 ″	4:00	4′ 6 ″	1:00	6′ 4 ″	3:30	9′ 6″	4:00
22′ 11 ″	8:00	19′ 4 ″	8:00	16′ 5 ″	8:00	9′ 6″	4:00
14′ 5 ″	8:00	16′ 3 ″	8:00	19′ 3 ″	8:00		
23′ 11 ″	6:00	14′ 3 ″	6:00	20′ 7 ″	8:00		
				25′ 6 ″	7:00		
				28′ 4 ″	6:30		
2′ 3 ″	2:00						
6′ 6 ″	4:00						
4′ 6 ″	2:00						
20′ 9 ″	8:00						
16′ 3 ″	6:00			12′ 0 ″	4:00		
20′ 3 ″	6:00			11′ 6 ″	4:00		
				11′ 5 ″	4:00		
TOTALS 240′ 3½″	83:50	103′ 1½″	37:30	190′ 4½″	68:50	62′ 8″	28:45
AVERAGES 2.87′ per hr.		**2.75′ per hr.**		**2.76′ per hr.**		**2.18′ per hr.**	

Table III. Welding Data

Current Used Kw-Hr	Welding Footage*	Welding Time Hr Min	Number of Arc Welders
90	28′ 5 ″	8 50	1
95	63′ 7½″	23 50	4
115	59′ 7 ″	26 00	4
110	75′ 4 ″	21 30	4
60	33′ 5 ″	12 30	4 (½ Day)
130	68′ 2 ″	28 00	4
90	49′ 11 ″	24 00	3
100	58′ 9 ″	20 00	3
70	25′ 6 ″	7 00	1
40	28′ 4 ″	6 30	1
20	2′ 3 ″	2 00	1
30	6′ 6 ″	4 00	1
20	4′ 6 ″	2 00	1
40	20′ 9 ″	8 00	1
60	28′ 3 ″	10 00	2
70	31′ 9 ″	10 00	2
30	11′ 5 ″	4 00	1
30	13′ 9 ″	10 00	1
TOTALS 1,200	610′ 2½″	228 10	

*Welding footage is based on ⅜ in. double pass weld. Average speed was 2.67 ft of weld, or 64 in. of bead, per hr.

No More Priorities!

Within a few months steel, copper and aluminum may be obtained only under the Controlled Materials Plan. If you use these materials, you should become familiar with this plan.

NO MORE priorities in a measure will be good news. The priority system, though it has served an excellent purpose, has had its handicaps too. So many who are working under priorities tried their best to get A-10 ratings only to find that anything less than an A-2 meant they would get no material. When they secured an A-2 rating, they found that deliveries were being made only on A-1-J, but, when finally given an A-1-J, there were so many A-1-J's around that an A-1 or an AA-5 or some other rating as far away as the end of the rainbow was needed to produce results.

It's Now CMP

The priority system will now be gradually replaced by the Controlled Material Plan. The main purpose of this plan is to make certain that production schedules are adjusted within the material supply so that production requirements will be met. This will be accomplished by two steps: 1—Adjusting requirements for critical materials to the supply. 2—Making the qualities and types of materials needed available at the time required to meet approved programs.

Under CMP, allotments of critical material will be made through several Claimant Agencies — various Government agencies such as the War Department, Navy, Maritime Commission, Aircraft Scheduling Unit, Office of Lend Lease, Board of Economic Warfare and Office of Civilian Supply—to prime contractors producing essential goods. Prime contractors in turn will divide the allotments with their subcontractors and suppliers.

All Critical Metals Involved

Carbon and alloy steels, copper and aluminum, the basic and most critical of our war production materials, are to be the first controlled materials. They will be directly allotted under this plan, which becomes effective in various stages during the second quarter of 1943 and will be in full operation by July 1st of next year.

Material distribution methods under this plan will be, in effect, "vertical allotments." As such it will gradually replace the present priorities system, including the Production Requirement Plan, which is now operating on a horizontal basis.

Each of the above Claimant Agencies will break down its submission of material requirements into materials for: (1) production; (2) construction and facilities; (3) maintenance, repair and operating supplies. Requirements for the construction and facilities will include industrial machinery and equipment. This will be channelled through the Construction and Facilities Branch, Office of Program Determination.

Allotment Numbers

When requirements have been brought into balance with supply and the programs of the various Claimant Agencies approved, the WPB vice-chairman of Program Determination (who is also chairman of the Requirements Committee) will allocate the material with the advice of the Requirements Committee. Under this program, authorized quantities of the three controlled materials (steel, copper and aluminum) will be distributed to each Claimant Agency, which in turn will distribute these broad allotments among the contractors by means of "allotment numbers."

An allotment number will constitute the right to receive delivery. Subcontractors and suppliers of prime contractors will have passed on to them allotment numbers to obtain the necessary material to carry out their activities. The deliveries of controlled materials bearing allotment numbers shall not be affected by previous ratings. Deliveries of materials other than controlled materials will continue to be governed by previous ratings and shall be subject to the priority regulations and orders of the WPB.

Preference Ratings

Each company receiving an allotment number carrying an allocation of the Controlled Materials Plan will also receive a preference rating for use in obtaining other materials. The preference rating accompanied by an allocation number will be higher than other ratings in the same category but will not take precedence over higher ratings. For example, AA-3 plus an allotment number, is higher than AA-3, without the number, but it is not as high as AA-2X. The preference rating also will solve complications that might otherwise occur in the production and delivery of manufactured items.

As the Controlled Material Plan goes into effect, the job of cutting out non-essential production, military or otherwise, will be completed. Under CMP, each Claimant Agency programs the quantities of end-products, that is, guns, planes, ships, bicycles, etc. most urgently needed for each quarter period. From the program of materials for each of these items, the agency will make up a consolidated estimate of the total requirements. Detailed estimates for the second quarter of 1943 must be submitted by January 1st. At the same time similar estimates must be submitted for the remaining quarters of 1943 and the first quarter of 1944. By this arrangement, the Requirements Committee will be given a general picture of the requirements for 18 months in advance.

Class A and Class B Products

When allotments are made by the Requirements Committee, they will be submitted to the prime contractors through Claimant Agencies. Manufacturers working on items of highly important military nature such as tanks, ships, aircraft and the like generally are contracted for by or through a Claimant Agency and are Class A producers and will receive their allocation with their allotment number direct from the agency.

Producers of Class B products such as welding rods and electrodes, hardware, electrical appliances, parts frequently incorporated in other products, and civilian items generally will receive their allotment from WPB and its branches, which in turn will receive allotments through the Office of Civilian Supply.

Any of the Claimant Agencies may allot up to 105% of its monthly allotment each month. This over allotment is intended as an incentive plan to stimulate increased production from producers of controlled materials. Claimant Agencies will also be authorized to make future quarter al-

lotments on a basis of declining percentages of allotments established for the current quarter. These percentages are: for the quarter immediately following the one for which a definite allotment has been made, 80%; for the next following quarter, 60%; and for all later quarters, 40%.

The plan, under its present set up, will undoubtedly be flexible enough to permit a limited amount of materials to be given out without allotment numbers. Special provisions, for instance, have been made for allotments of controlled materials to warehouses so that they may handle small orders without allotment numbers.

To Control Inventories

A new form of inventory control is to be established, requiring that every primary and secondary producer make sure that his inventories of controlled materials are not in excess of the specified amount. This will necessitate the submission of an inventory statement showing his position at the end of each calendar quarter. This statement must be submitted not later than 15 days after the end of the quarter.

For those who are to be affected by the Controlled Materials Plan, the following time table for the transition from the existing system to full operation of the Controlled Materials Plan is provided:

First, Claimant Agencies will assemble complete bills of materials during November and December. On January 1st, the Agencies will submit their first estimate of requirements to the branch handling Controlled Materials. Copies of this estimate will go to the Requirements Committee.

By January 15th, the Controlled Material branches will have analyzed all the requirements and have made preliminary reconciliations to the extent possible between requirements and supply. At the same time the Claimant Agencies and the prime consumers, in order to be in readiness for distribution of allotments to them by the Requirements Committee, will be developing information necessary in making their own allotments.

Quarterly Allotments

The Requirements Committee will make allotments on February 1 of controlled materials to Claimant Agencies for the second quarter of 1943. During February and March, 1943, the prime consumers will divide up allotments authorized by Claimant Agencies between secondary consumers, and consumers will place authorized orders with suppliers.

Under the new set-up, it is hoped that by March 15th, users of Controlled Materials will have placed authorized orders for April and later for deliveries as authorized. Subsequently, the Controlled Materials Branches will watch the placement of orders on mills and mills' shipments and give assistance in placing orders to the authorized user of controlled materials who has been unable to obtain acceptance of authorized orders.

The Controlled Materials Plan will be in full operation by July 1st. Until that time, existing procedures, including preference ratings and PRP certificates and individual material allocations under M orders, will continue in effect for the consumer who has been unable to qualify under CMP. Those remote secondary consumers who have been unable to obtain their allotment under CMP in time to meet the requirements for the second quarter of 1943 will be authorized to continue purchases under PRP equal to their first quarter authorizations. To prevent duplications, each company operating under PRP will be required to cancel authorization under PRP in amounts equal to their CMP allotments. The total authorizations outstanding for any period will not be permitted to exceed the available supply.

If CMP Affects You—

The above interpretations highlight what the War Production Board hopes to accomplish. Features of this plan are really flexible and will be subjected to revision. Therefore, it is suggested that the reader who will be affected by CMP should obtain a copy of the "Controlled Materials Plan—November 2, 1942" from the War Production Board. This 58 page booklet not only describes the plan but illustrates the various forms that will be used in its workings.

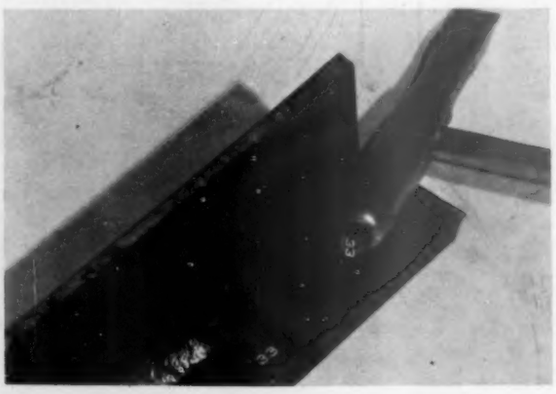
Know Your Weldors

WELDING shop personnel has increased in such nearly unbelievable proportions during recent months that it is not now unusual to find shops employing welding crews of from 50 to 15,000 workers. This increase in welding personnel has brought about a problem of indicating the work done by individual weldors.

There are several reasons why this information must be obtained. First, it determines those who are doing imperfect work so that they can either be properly instructed or discharged. Of equal importance, it also indicates the competent, skilled workmen who are capable of assuming greater responsibilities. Finally, it assures each weldor of proper pay if the work is on a piece work basis.

The use of paint or grease crayon has become somewhat passé because of the increased tempo of war production. It is too easy for an unscrupulous weldor to remove his identification mark from a poor weld and place it next to the work of a good weldor, or, where piece work rates are involved, to change marks of the previous shift in order to claim a portion of their work.

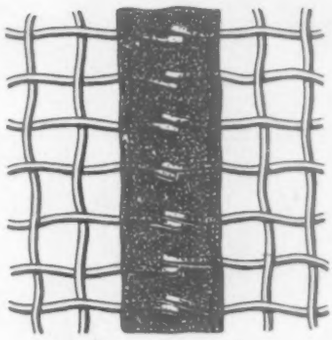
To combat these disadvantages, some companies have adopted a system of permanent marking. Each weldor is given a definite identification mark, either a numerical series, an alphabetical series or a distinctive character, and his work is marked in the metal alongside his bead with this symbol, the marks being placed at convenient intervals. Likewise, on piece work, an identifying mark is stamped into the metal at the end of the bead when the day's work is done. Thus there can be no questions.



This combination chipping and marking hammer provides a handy tool for making permanent identification marks on welds.

Photo by Atlas Welding Accessories Co.

Wire Cloth Repair Methods



Soft Soldered Joint
½ in. Lap

Fig. 1—The soft soldering method of repair closes too many mesh openings and is not so strong as the other types of joints illustrated.

Due to priority restrictions, many plants are unable to replace their wire cloth filter screens. Even if replacements can be obtained, there exists a moral obligation to conserve strategic metals. This article tells how to get a maximum of service from Monel, nickel, Inconel or other non-ferrous screens by repairing them with silver-brazing.

By **K. M. SPICER**
Development and Research Div., The International Nickel Co., Inc.

MANY OF THE PROCESSES used in the metallurgical field, the chemical industry, for the production of synthetic rubber and in the manufacture of pulp and paper are dependent upon the efficient, continuous operation of gravity or vacuum-type filters. The heart of these filters is generally an open cylinder or closed drum covered with Monel, nickel, Inconel or other non-ferrous wire and wire cloth.

Injuries to such wire cloth are bound to occur from time to time, and repairs must be made. Patching wire screens is an extremely ticklish silver-brazing operation, calling for a high degree of skill on the part of the welding operator. The wrong method not only decreases the trouble-free life of the repair, but it also interferes with production by closing an excessive amount of the screen meshes. Hence this article was written.

The Wrong Way

Fig. 1 illustrates a commonly used method of repair. The screen edges are lapped ⅜ to ½ in., and the area is filled with soft solder.

This type of lapped joint will not approach the strength of the wire cloth unless an excessive amount of material is overlapped. In the latter case, however, a large number of mesh openings are closed, with consequent impairment of production. Tensile tests on joints of this type in 32 by 40 mesh Monel wire show a lap of ½ in. is necessary to obtain 85% of the strength of the parent stock. This method of repair, therefore, is not generally to be recommended.

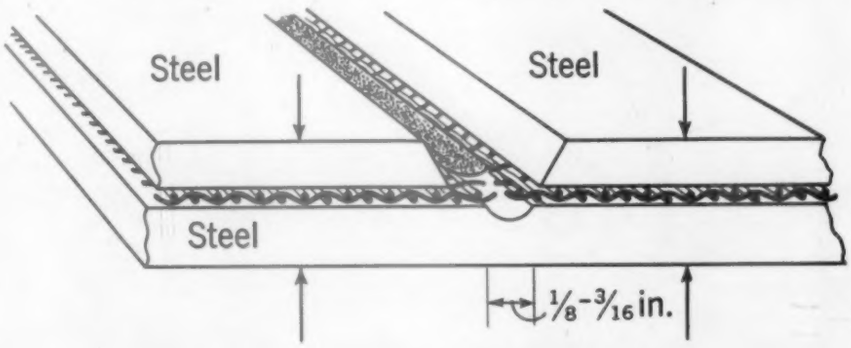
Figs. 2, 3 and 4 illustrate preferred methods that have been tried and found to be practicable for the repairing of Monel, nickel, Inconel and certain other non-ferrous types of wire cloth.

General Instructions

First, the wire cloth should be removed from the cylinder or drum. The area to be repaired must then be carefully cleaned to remove all oil, grease, dirt or production residue as these substances interfere with the binding qualities of a brazed joint. The damaged area is next carefully trimmed to remove broken wires and to prepare the edges for the particular type of joint to be made.

To conserve valuable screen, it is advisable to make a small test or pilot joint on scrap material before commencing the actual repair work. This should always be done when the weldor is not accustomed to fine brazing jobs.

In Fig. 2 is shown a suitable fixture for holding the work. It consists of (1) a thick steel base plate provided with a groove approximately 1/32 in. deep by ⅛ to 3/16 in. wide and (2) bars for holding down the wire cloth during the joining operation. The hold-down bars should be fairly heavy, especially where clamps cannot conveniently be used.



This fixture suitable for all butt joints

Fig. 2—After the screen edges have been trimmed and set up in the fixture as shown, they are painted with a silver-brazing flux and alloy mixture and fused by oxy-acetylene flame. Strength of the joint may be increased by a second application of the flux-alloy mixture and re-fusing.

Fig. 3—This method is suitable for fine-meshed screen, and it makes a long-lasting joint. The edges to be joined are pre-tinned with silver-brazing alloy. The tinned edges are then butted together and fused.

They should be beveled as shown in the sketch in order to facilitate entry of the flame to the joint.

The Pretinning Method

Fine mesh screen (20 mesh and finer) for equipment which will be subjected to high stresses or vibration is preferably joined as shown in Fig. 3. This joint is made as follows:

The wire cloth is carefully trimmed by hand so that a cross wire will be at or near the extreme edge of the screen. The end of one screen is set up in the jig so that only two or three mesh openings are exposed. This edge is painted with a mixture of silver-brazing flux and 200 mesh silver-brazing alloy fillings. Care must be taken that the flux-alloy mixture is heavily loaded with alloy. The edge is then "tinned," using a very small oxy-acetylene flame.

The second piece of screen to be joined is similarly tinned. The two tinned edges are filed to remove any surface irregularities and are then butted together tightly in the fixture. After further light painting with the flux-alloy mixture, they are fused together with a very small flame. With care in the use of the torch, the number of closed mesh openings may be kept to a minimum.

Two Variations

The pretinning operation was omitted from the joint shown in Fig. 2. In this case, the screen edges were trimmed, set up in the fixture, painted with the flux-alloy mixture and then fused together. The strength of this type of joint may be increased (with only a minor decrease in thickness) by a second application of alloy and re-fusing with the flame.

Still another type of joint for screens is shown in Fig. 4. Here the joint is set up on an angle bar, with the "shute" or longitudinal wires of one screen interlocked behind the "warp" or cross wires of the other screen. The wire cloth was trimmed on one side of the joint so that a warp wire is at the extreme edge. In trimming the other side, the first warp wire was removed to leave a clearly exposed shute wire. The joint was then clamped, the flux and alloy applied, and the brazing completed in one pass.

Upon removal from the fixture, this joint will be flattened. The very small ridge which remains can be reduced toward the vanishing point by hammering lightly with a wooden mallet, using a smooth hardwood block as a dolly.

Table I shows tensile properties obtained on the four types of joints just described. The test samples were ½ in. wide, 32 by 40 mesh Monel wire containing 20 longitudinal wires in tension.

Fig. 5 illustrates still another method of joining, a method which can be used where maximum speed, unavailability of fixtures and/or maintenance of the filtering area must be considered and where high spots are not objectionable. The method is simple: a ¾ in. wide lock-seamed joint is painted with a heavy coating of flux-alloy mixture and fused.

For Larger-Mesh Cloth

Strong, narrow joints in wire cloth of 14 mesh and larger may be brazed directly with a filler rod instead of the mixture of flux and alloy fillings. After the mesh edges have been trimmed to remove long shute wires, they are butted together and clamped in a fixture like that of Fig. 2. The edges are then painted with brazing flux and are fused with silver-brazing alloy added by hand from a 1/32 in. diam rod.

Sometimes it is necessary to join Monel winding wire. This can best be done by means of the so-called "band saw" joint illustrated in Fig. 6. The beveled edges of the wire are held together with pliers while the silver solder "sandwiched" between the two edges is fused by a very small oxy-acetylene flame.

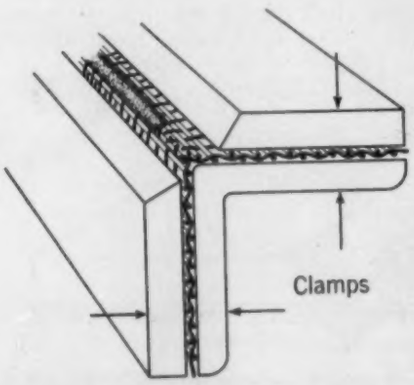


Fig. 4—This joint is set up on an angle bar, and the shute wires of one screen are interlocked behind the warp or cross wires of the other screen. The joint will be flattened upon removal from fixture.

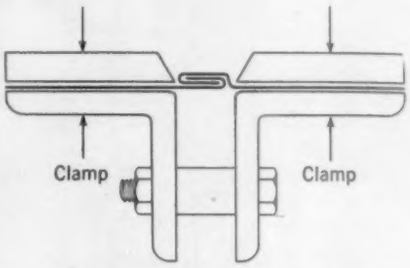


Fig. 5—The lock-seamed joint is simple, speedy and can be used wherever high spots are not objectionable.

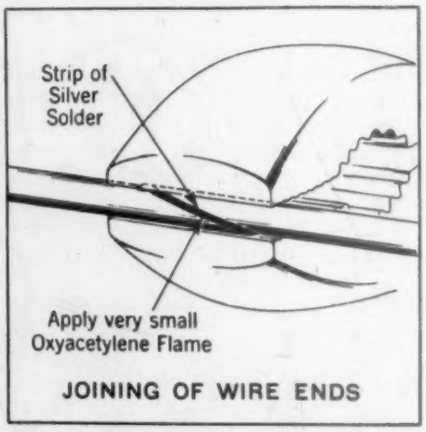


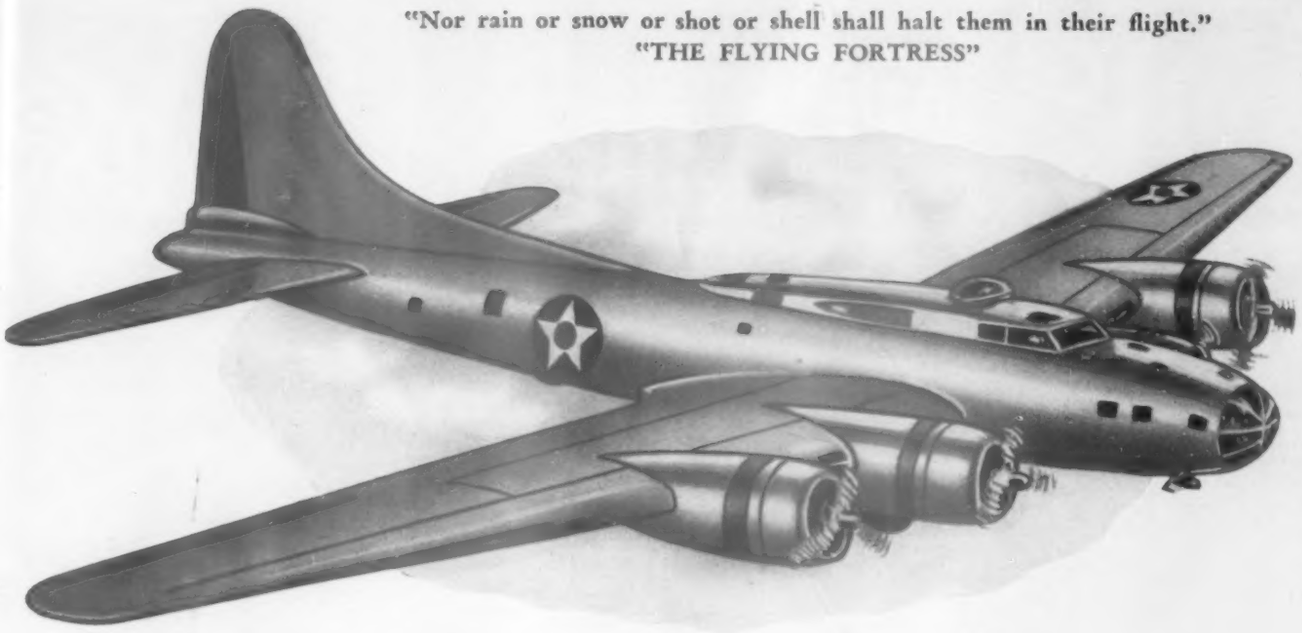
Fig. 6—The "band saw" joint is the best method of joining Monel winding wire. The beveled ends of the wire, with a strip of silver solder between them, are held together with pliers while the fusing is done with a flame.

Table I. Tensile Strength of Various Soldered Joints*

Fig. No.	Type of Joint	Breaking Strength Lb	No. Wires Pulled Out of Joint	Location of Break
	Wire cloth without joint.....	97.0		
1	Soft soldered	86.0	0	2 in. from joint
2	Butt	95.9	0	1 in. to 2 in. from joint
3	Butt, pretinned	93.2	0	¼ in. to 2 in from joint
4	90 deg angle, straightened.....	92.2	2.5	At joint

*Values given are averages of four test strips of each type of joint.

"Nor rain or snow or shot or shell shall halt them in their flight."
"THE FLYING FORTRESS"



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PROCESS ELECTRIC RESISTANCE WELDING
STORED ENERGY · VARIABLE PRESSURE
WITH PREHEATING · WITH PRECOMPRESSION

The Technical Slant

Books are the ever-burning lamps of accumulated wisdom.—*G. W. Curtis.*

Welding

WELDING HANDBOOK, 1942. *Published by the American Welding Society, New York, 1942. Fabricoid, 6 x 9 inches, 1,593 pages. Price $6.00.*

The 1942 edition of the *Welding Handbook*, a definite improvement over its predecessor of four years ago, has been increased in size by nearly 400 pages.

On the whole, the outstanding improvement of the enlarged edition lies in its impartial treatment of the subject matter. Unlike the previous edition, for which individuals contributed chapters, the new volume is the collaborative work of 270 leading welding experts. Outstanding authorities in each field were selected as members of the committees preparing the respective chapters. In this manner, impartial treatment of the subject matter was obtained.

The volume might well be considered one of seven sections since the material contained may be readily grouped under seven headings. The book opens with three chapters devoted to the fundamentals of welding, the materials used, the weldability of steels. This section is followed by sections relating to allied processes, metals, training, inspection, and safety design consideration and applications.

The aim of this mammoth work on welding was evidently to make sure that its statements are accurate and remarks authoritative. There are, however, discrepancies in nomenclature which will tend to confuse the lay reader. These have undoubtedly arisen from the fact that the Society is apparently unwilling to establish definite limitations for various welding terms.

The text of this volume is generally arranged in handbook style, and its primary purpose, obviously, is that of a handbook to give authoritative, up-to-date welding information to the engineer. Nevertheless, the material has been presented in a logical sequence with enough explanatory matter so that it may be used as a textbook in engineering schools or as a reference book in trade schools.

» «

Welding Training

ARC WELDING JOB TRAINING UNITS. *By the Staff of Dunwoody Industrial Institute. Published by American Technical Society, Chicago, 1942. Spiral bound paper, 8½ x 11 in., 103 pages. Price $1.25.*

GAS WELDING JOB TRAINING UNITS. *By the Staff of Dunwoody Industrial Institute. Published by American Technical Society, 1942. Spiral bound paper, 8½ x 11 in., 92 pages. Price $1.25.*

These two job training units or manuals have been prepared as a result of years of experience in vocational training at the Dunwoody Institute. As such they are ideal for use in any plant training program for mass training of weldors for war production. While brief, the manuals are concise, offering many suggestions that will be of value in training courses.

The arc welding manual gives the student information and suggestions on how to do 40 different types of arc welding jobs, all of these jobs being designed to promote his efficiency in welding until he is finally ready to take the prescribed test as a means of completing the course and passing on to a job in war industry. The first 32 jobs are to acquaint him with arc welding in all positions; these are followed by 8 additional jobs to provide the welding student with a knowledge of how to handle various metals and alloy materials. Each job is set up to give the student definite information on a particular subject. He is told the object of the job, the equipment needed, general instructions and precautions, operating steps and after the job is completed how his work is checked. There are also review questions to ascertain if the student has obtained the utmost knowledge in the performance of the task at hand.

The gas welding manual also requires the student to do 40 specific jobs in gas welding so as to learn the proper technique to be used in this type of welding. Here again his work is such that he becomes acquainted with the various welding positions as well as with knowledge as to the means whereby various materials can be gas welded.

Each of these manuals includes job instruction sheets for each job, questions on each job, job check sheets and hints on the manipulation of the arc and torch as well as other important welding factors. The check sheet contains the correct answers to the various questions asked throughout the manual.

» «

Plant Protection

PLANT PROTECTION. *By E. A. Schurman. Published by Cornell Maritime Press, New York, 1942. Cloth, 5 x 7½ in., 148 pages. Price $2.00.*

In a concise handbook for industry, dealing with the organization and administration of a guard force, the chief of plant protection at Glenn L. Martin Co. points out how to prevent sabotage and espionage in both small and large plants.

The book opens with a chapter on selection of personnel and carries on by giving detailed information on organization, structure and operation plans suitable for a protection force of any size. The author shows how by proper planning the organization can be expanded for an increased staff or contracted with only simple modification to apply equally as well to a small plant protection unit. The information regarding the proper use of records and forms, as well as the equipment and training program of a guard staff, is quite complete. It is also pointed out that in certain operations it is desirable to have women guards.

Pointers on self control and self defense are clearly illustrated so that the book is quite suitable for use in training guard personnel. Samples of various types of record sheets are included which would be of value in the establishment of a protection personnel group.

» «

Arbitration

LABOR ARBITRATION — PRINCIPLES *and* PROCEDURES. *By Dr. John A. Lapp. Published by the National Foremen's Institute, Deep River, Conn., 1942. Cloth, 5 x 7 in., 236 pages. Price $3.50.*

Dr. Lapp, a well-known authority on labor arbitration, has written a book which, though not exactly practical, is truly authoritative. This is the first book devoted exclusively to this subject to come to this reviewer's attention.

The book opens with a concise exposition of the whole field of labor arbitration. There are descriptions of the various types of labor cases and the laws pertaining to labor arbitration. This section is followed by a detailed guide to the manners of conducting arbitration. There are chapters on arbitration tribunals, the practice of arbitration procedures, the case and the settlement. All of these are quite complete, leaving no details uncovered. There is also an appendix containing actual examples of arbitration agreements.

Compiled by an authority, this manual will undoubtedly prove to be of great value in the securing of peaceful settlements of labor disputes. It should be particularly important now because our national policy seems to be that of resorting to arbitration on all labor disagreements, and this civil policy seems likely to continue longer than the "duration."

» «

Labor

BREAKING THE SKILLED LABOR BOTTLENECK. *By Eugene J. Benge. Published by National Foremen's Institute, Deep River, Conn., 1942. Cloth 8 x 10 in., 48 pages. Price $2.50.*

In a brief manual, the author points out ways in which labor shortages may be met today. The principles discussed are based upon many years of experience in all phases of shop practice with workers and executives of all types. The study brings to light many ways in which labor shortages may be avoided or overcome. From the first chapter, which deals with the nature of skill, the brief book is packed with practicable ideas.

The author explains how to make the worker produce and tells what steps can be taken to train green hands in half the time usually required. These intensive training programs are the most promising

(Continued on page 54)

GIVE US MORE TANKS!

That is where welding came into its own—for precious hours on the assembly line then could be saved—to produce more tanks with the same number of men on the same line.

And that is where the new welding electrode developed exclusively by PAGE for welding armor plate went to work—after it had met successfully all ballistic tests on plates submitted to the Army Ordnance Department by the tank manufacturers.

Chalk that up as another important contribution by PAGE that will be at the service of industry when Victory brings peace.

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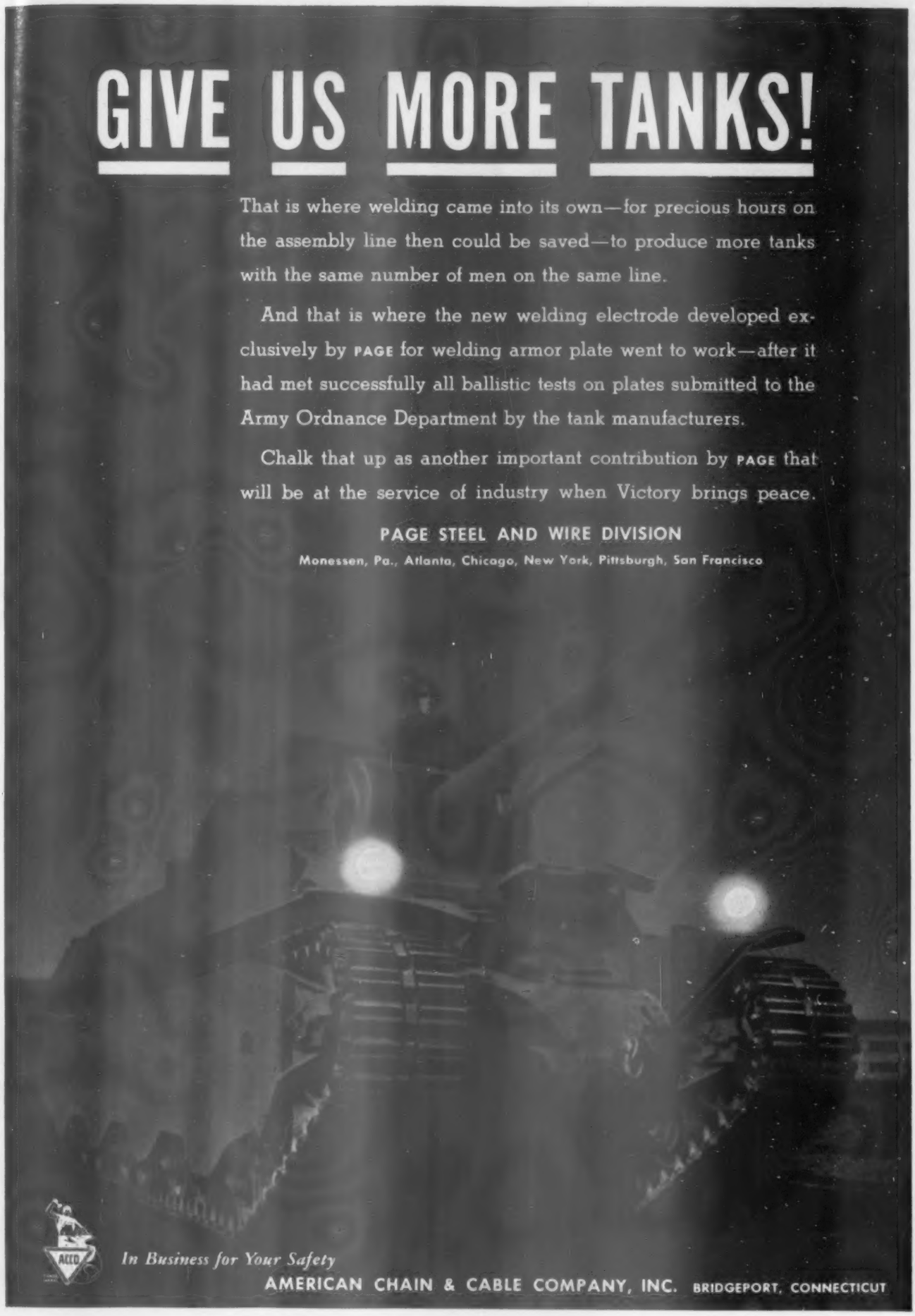

In Business for Your Safety

AMERICAN CHAIN & CABLE COMPANY, INC. BRIDGEPORT, CONNECTICUT

The Technical Slant

(Concluded from page 52)

method for showing immediate results. There are suggested ways of inventorying the personnel force (the author points out how the personnel labor resources may be used to the greatest advantage). Job analysis suggestions are given on ways and means of dividing and allocating the work to spare highly trained men for their own specialized skills.

Pointers are also given on up-rating training principles, with psychological suggestions as to how the foremen or supervisor can obtain more satisfactory results, while an appendix is devoted to tables of the times taken to learn particular jobs.

This manual should be of tremendous help to foremen, supervisors, instructors and all others who are endeavoring to meet the full-scale mobilization problems of industry now demanded by our war conversion program.

» «

Mathematics

PLANE TRIGONOMETRY MADE PLAIN. *By A. B. Carson. Published by American Technical Society, Chicago, 1942. Cloth, 5½ x 8½ in., 389 pages. Price $2.75.*

Trigonometry is today playing an important part in our war effort so this is an extremely timely volume. It deals with the fundamentals of plane trigonometry in greater detail than is the usual practice in books of this nature, and the discussion is presented in a manner that enables the reader to visualize how and why the principles are employed and their specific purpose.

Emphasis has been placed on the practical application of trigonometric principles in the solution of every day problems. Each chapter includes numerous problems (to which no answers are given), questions (with answers) and a summary of the material presented. There are over 100 pages of tables of natural trigonometric functions, logarithms of trigonometric functions and logarithms of numbers.

Here is an ideal book for the student, either at school or at home, and a book that will also be of practical value to one desiring to take a "refresher" course.

» «

Arc Welding

PROCEDURE HANDBOOK OF ARC WELDING DESIGN AND PRACTICE. SEVENTH EDITION. *Published by The Lincoln Electric Company, Cleveland, 1942. Similated leather, 6 x 9 in., 1,308 pages. Price $1.50.*

Since first published in 1933, the Procedure Handbook of Arc Welding Design and Practice has gone through 23 printings. The new edition has been greatly enlarged over its predecessors and has been improved in many ways. A new feature is the acknowledgment by the publisher of nearly 300 contributors to the edition.

New information is given in the handbook on such subjects as welding symbols, allowable stresses, preheating for welding, speeds and cost of welding, stress relieving, general metallurgical characteristics of metals and alloys, the weldability of aluminum, tubular construction and appearance and styling of welded designs.

The book is divided into 8 chapters, opening with a discussion of welding methods and equipment, which includes a concise discussion of all types of welding including a comprehensive discussion on A-C vs. D-C in welding. This is followed by a 116-page discussion of the technique of welding various types of joints, location of welds, standard nomenclature and codes. Chapter 3 deals with procedure, speeds and cost, followed with a brief chapter on weld metals and methods of testing. On methods of testing information is included on tensile, free bend, guided bend, nick-break, impact, specific gravity, fatigue tests, radiographic test and a test for resistance to corrosion. The other chapters in the book include weldability of metals, welded steel construction, designing of arc welded structures and typical applications of arc welding in manufacture, construction and maintenance. This last chapter is practically a book in itself in that it contains 439 pages clearly illustrating the many diversified applications that are being made of welding today. In all, there are 1,810 illustrations in the best yet edition of Procedure Handbook of Arc Welding Design and Practice.

» «

Some men thirst after fame, some after love, and some after money, but they all thirst after eating salted peanuts . . .

The NEW G-R MODEL 45
POWER FACTOR CORRECTED

NOW! Stepless Heat Control from 20 to 625 AMPERES ON ONE MACHINE!!

HERE is the FIRST FULL RANGE *manual welder*, able to handle any job from light sheet metal to the heaviest production assignments. It meets every war demand for heavy fabrication, will be equally useful when peace brings a changeover to the manufacture of lighter goods.

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G-R 45 includes all the tested performance features of other G-R Welders...high efficiency; G-R flux-diversion type transformer; stable arc; and safety for the operator.

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The scarcity of copper and copper alloys now makes it even more important to purchase gas welding and flame cutting apparatus of absolutely proven quality.

Poorly designed or inefficiently functioning torches or pressure reducing regulators no longer merely constitute an annoyance and an expense, but their untimely replacement wastes precious metals.

These are some of the reasons why one customer alone has purchased to date over 15,000 VICTOR Aircraft Welding and Cutting Units No. 1, as illustrated.

Write for the new 64-page VICTOR Apparatus Catalog in regard to which one publisher says — "Rates a publication medal for its graphic, colorful portrayal of a story of welding equipment slanted to the war effort. An excellent handbook — a dramatic presentation — for both service workers and engineers."

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Pipe Bend Allowances

By **W. F. SCHAPHORST**

A weldor is frequently confronted with the problem of determining the expansion allowance necessary when bending a piece of pipe for one of the four conditions shown to the right of column E in the alignment chart below. This allowance can be calculated using the formula:

$$\text{Bend Allowance} = \frac{\text{Average Radius} \times \text{Factor Q}}{\text{OD of pipe}}$$

All dimensions in inches. Factor Q will differ for different types of bends. It is, however, .0026 for bend No. 1, .0052 for No. 2, .0104 for No. 3, and .013 for No. 4.

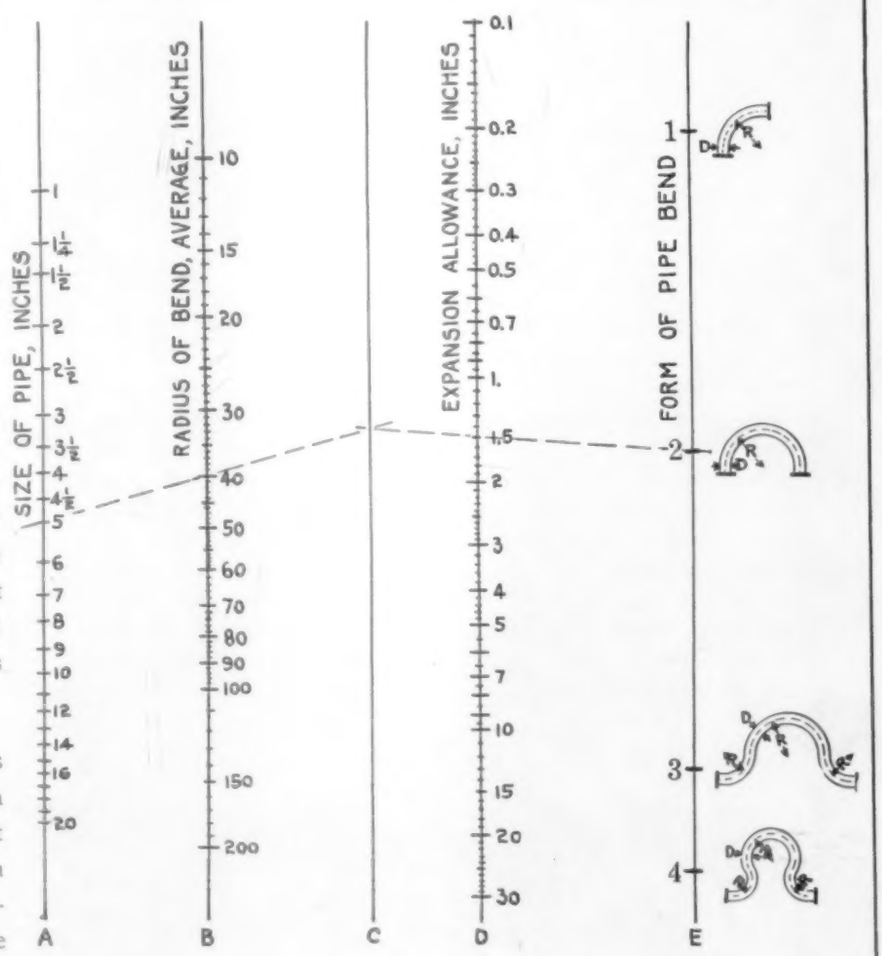
To eliminate the mathematics of this work, there is provided an alignment chart with all of these operations already performed. The radii has been squared, exact outside diameters are employed and the proper Factor Q is used.

Knowing the radius of a bend, the size of the pipe, the bend form, the expansion allowance can be readily found in Column D. For example, what expansion must be allowed when a 5-in. pipe is bent to a radius of 40 in., the bend being a common U bend, such as shown in No. 2 of Column E.

The solution to this problem is shown by the dotted lines drawn across the chart. Draw a straight line to connect 5 of column A with 40, column B, and locate the intersection with column C. From the point of intersection on C extend a line to the mark in Column E opposite No. 2. The intersection of this line on Column D gives the answer as 1.5 in., the expansion allowance.

If the size of the pipe were the same, 5 in., the average radius 40 in. and the bend were a "No. 4" bend, the expansion allowance would be 3.7 in. If the bend were a "No. 3" bend, the expansion allowance would be 3 in. If the bend were a "No. 1" bend the expansion allowance would be 0.75 in.

Similarly if the expansion allowance is already known, the form of bend is known, and the size of pipe is known, the average radius to which the bend should be made may be determined. In other words, knowing any three of the four factors given in columns A, B, D and E, the fourth or unknown factor is easily determined by following the method as explained above.



Meco is KEEPING FAITH with you who have made our War-effort possible!

Several years ago, because we had learned to count on your increasing use of Meco Equipment, we started a plant enlargement program which finds us today with production facilities many times greater than would ever have been possible without your peace-time support.

It is you, whose patronage has made possible our multiplied contribution to the war effort.

It is you for whom we are mostly concerned, to whom we are anxious to give all possible service in accordance with the war effort.

We urge you to take your welding equipment priorities to your Meco Distributor. We have worked with him since the first days of defense production to evolve an efficient method of handling the various ratings. The Meco Distributor will be able to guide you—to show you how to obtain the best consideration on the basis of your own activities toward winning the war. He has served you well in peace-times—will serve you to even greater advantage in these times. We are giving him first consideration because he, too, has helped make our war production efforts what they are today.

A MESSAGE TO OUR DISTRIBUTORS

The War Program, to which we have devoted all of our facilities, is now reaching a third stage—one that will enable us to give greater support to all of our distributors. The program has involved—first—construction and conversion of plants in which to make the implements of war—planes, tanks, ships—guns—ammunition. The second factor has been one of supplying tools to these new or converted plants...the necessary oxy-acetylene equipment to give them maximum production.

The next stage, will come from outside of the so-called war production areas—will involve the procurement of raw and semi-finished materials to keep defense plants running at top—168 hours—production. Among these are—the Petroleum industry, the Chemical industry, Mining, Lumbering—Steel and Iron—and many others.

As the importance of these producers of basic materials increases, so too will *their* opportunities to secure needed equipment increase.

Our long experience in handling priority matters will serve you to best advantage in securing the best possible rating for your customers.

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Oxy-Acetylene Cutting and Welding Equipment

MODERN ENGINEERING CO.

3413 PINE BOULEVARD ST. LOUIS, MISSOURI

On the Job

Weldor Stretches a Skid

By M. T. Pate

Through a design error, a skid fabricated for mounting a certain size of pipe-line pump was made so short that the mounting afforded no protection to the pump's valve covers. A weldor was called upon to remedy the shortcoming.

This welded extension to a skid for pump mounting gave work space around the valves.

The weldor first cut out a pair of splice plates from ⅝ in. steel. One end of each plate was notched to fit over the skid end, while the other end was shaped to permit welding in a 4 in. drill pipe. The two plates were then welded to the skid, and the pipe cross brace was set in place.

Chains or cables could be hitched on the cross member for lifting or towing. The extension also provided a firm structure to take the thrust of jacks or other tensioning devices used to maintain V-belt drives at full efficiency.

» «

One-Way Ticket for Hitler

An all-welded sign to encourage scrap collection was recently devised by E. D. Anderson, Kansas City district manager of The Lincoln Electric Co., for his front office window. The sign, formed from odds and ends of scrap steel as the accompanying illustration shows, was arc welded in its entirety, even the letters of the message being welded to the background plates. The letters, it is interesting to note, were formed from scrap stub ends of electrodes.

This arc welded plea to provide Hitler with transportation for a one-way trip attracted the attention of thousands of Kansas City citizens.

» «

Brazing Saves Tin

Ordinary solder is 48% tin—because of the war, now one of the scarcest of all metals. At least four tons of tin a year are saved at the Westinghouse East Pittsburgh works by eliminating the use of solder in the construction of electric motors and generators. The loose ends of copper wire are clamped together and brazed with a strip of phos-copper. No solder at all is required, nor is any tin needed to coat the ends of the copper wire.

This workman no longer connects by soldering—a tin consuming process. Instead he uses brazing to make the 432 wire connections needed in this electric motor.

» «

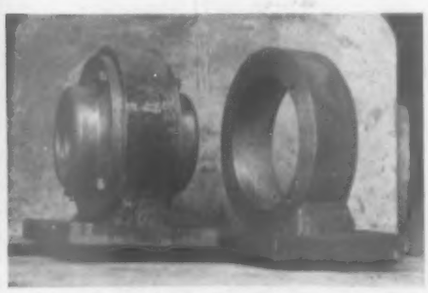
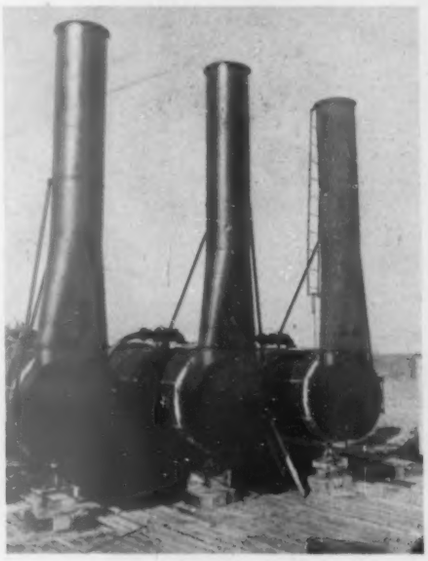


Photo by Chester L. Wright

Stack Handling Device

By Charles C. Lynde

To eliminate the need for climbing the stacks of a battery of portable boilers, the weldor for a drilling contractor welded an eye at each end of the stack sections. Between these eyes, a length of ½ in. wire rope was strung.



Stacks can be moved or set with this guide line in a fourth the time required by other methods of attaching the lift.

Use of the wire guide line permitted the removal of the ladder from each stack (ladder still on the right stack in accompanying illustration) and also eliminated the former practice of attempting to place a loop around the top flange of the stack by climbing the winch truck boom or mounting a long ladder balanced on the ground. To lift off the stacks, the winch line hook is simply looped under the wire line, the slack taken up and the lifting device slid up the wire until it reaches the top. Direct pull and proper balance when clearing the stack from the boiler breeching can thus be obtained.

A heavy band, welded around each stack at the balance, was provided with a loop through which the hook and winch line could be threaded after the stacks were laid down. By threading the line through the three loops, the stacks could be loaded together for transportation to the next site.

» «

These steam roller bearing housings (left) were fabricated by arc welding in order to replace cast iron housings which were constantly breaking. The procedure was simple: a section of heavy tubing was cut to fit and welded to a flat base. The end bells were welded, too, but later machining has removed the evidence.

Under the hardships of daily use Willson Industrial Safety Devices stand up longer, and yet provide maximum comfort and protection.

Our local Willson Safety Service Representative will help you select the specific Willson Goggle, Respirator, Gas Mask, Welding or Blasting Helmet for your industrial hazard.

GOGGLES • RESPIRATORS • GAS MASKS • HELMETS

DOUBLE WILLSON

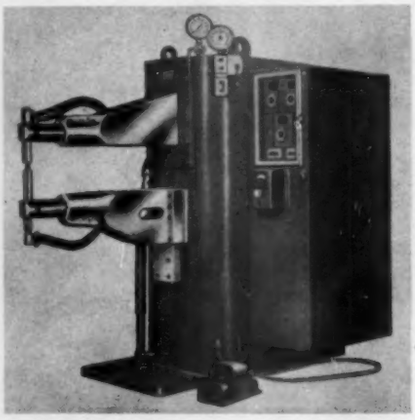
PRODUCTS INCORPORATED

READING, PA. U.S.A.

New Products to Use

Rocker Arm Welder

★ A new spot welding machine of the rocker arm type, **Sciaky PMCR-2S4** or **PMCR-2S16,** is now available with this manufacturer's patented features of

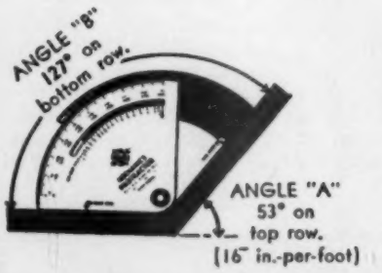


Rocker arm welder, stored energy type, for aluminum alloy sheets up to 0.080 in. thick.

stored energy with preheating and variable pressure with precompression. It will handle up to 0.080 plus 0.080 in. aluminum alloy sheets and is capable of making 70 spot welds per minute on 0.040 plus 0.040 in. sheets. Welding stroke is ½ in., retraction 3½ in., throat depth 34 in. For air at 100 psi, the total pressure between the electrodes is 3,000 lb. Power requirements are 40 or 50 kw.

Sciaky Bros., 4915 West 67th St., Chicago.

» «



Wolfe mechanic's protractor. Measures both outside and inside angles.

Mechanic's Protractor

★ Angle measurement on the job is simplified by the **Wolfe mechanic's protractor** which gives readings for both outside angles (angles of bend or deflection) and inside (inclusive) angles up to 180 deg. It also gives the inch-per-foot pitch against degrees up to 24 in. per ft. (63° 26″.) In positions where the protractor itself cannot be used, the angle may be taken with a bevel and read from the protractor. Calibrations are stated to be sufficiently large to enable accurate readings and interpolations for fractional degrees. **Interstate Sales Co.,** 1123 Broadway, New York City.

» «

Die Electrode

★ The **American Agile Corp.,** 5806 Hough Ave., Cleveland, announces its **"Silver Series" electrodes.** These electrodes are suitable for either A-C or D-C use and are designed for the salvage of worn trimming dies, forming dies, punch dies, etc. They can also be used to form new dies.

Agile Silver electrodes cover a range of hardness from 40 to 70 Rockwell C.

» «

Clothing for Women Welders

★ A line of womens' clothing which combines safety, durability and smart styling is announced by the **General Electric Co.,** Schenectady, N. Y. The line includes leather sleeves, aprons, jackets, gloves, and a special head covering to be worn under the helmet. The latter garment was designed by Sally Victor, one of the country's leading milliners, in order to protect the hair from sparks and slag.

The new line supplements the G-E line of safety apparel for men weldors. Bulletin GEA-3295 gives complete details and specifications.

This feminine welding operator is wearing several items of the new G-E line of safety clothing especially designed for her sex.

Women's Safety Clothing

★ Made of specially selected chrome tanned cowhide, a new line of "tailored" protective clothing for women consists of a cap, short jacket, coat, overalls, sleeves and a 36 in. tailored apron. It is said to be the first line of its kind to be

This young lady has apparently solved the problem of how to weld in safety and still look feminine. Leather gauntlets, cap, helmet, goggles, a short leather jacket and overalls styled like slacks make up her protective ensemble.

styled according to accepted dressmaker patterns.

Though light in weight, the new garments will give adequate protection against flying sparks. Welted inseam construction is used throughout for extra strength and to add a note of "smartness." The overalls are styled like women's slacks. The flared trouser legs make the garment easy to put on and take off over safety shoes.

The cap is fashioned to cover the hair and ears during welding. It is shaped something like a bathing cap with flaps extending over the ears. The yoked backs of the tailored coat and the short jacket permit free arm movements.

A descriptive catalog is available on request to the **American Optical Co.**, Southbridge, Mass.

» «

Fire Extinguisher

★ To meet the demands for a variable spray nozzle without a straight stream, the new **Alfcospray** has just been introduced. A slight turn of the tip from the shut-off position immediately gives a cone spray of 40 deg. Further rotation produces increasing cones up to a full curtain of 150 deg., after which a reversal back to shut-off follows without any intervening straight stream. The varying cones provide a large volume of water suitable for extinguishment of heavy oil fires and to prevent the spreading of fires from incendiary bombs. The spray is also said to be able to knock down heavy smoke and to dissipate poisonous fumes. **American-LaFrance-Foamite Corp.**, Elmira, N. Y.

Easier to handle because of special features found in no other cleaning tools, and *longer-lasting* — CMD Chipping Hammers are speeding up removal of slag, spatter, and welds in hundreds of shipyards and war plants. First choice of experienced welders for 17 years, CMD hammers are more popular than ever now.

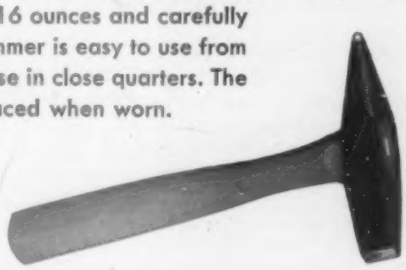
CHIPPING HAMMERS

First Choice of Welders for 17 Years!

TYPE CB — **TRIPLE-DUTY HAMMER**

Three Tools in One—Chisel, Drift and Brush

This time-saver has many practical features. Without setting down the welding rod holder, the welder can chip or brush away the slag and spatter. Weighing only 16 ounces and carefully balanced, this CMD Hammer is easy to use from any position. Ideal for use in close quarters. The wire brush can be replaced when worn.



TYPE C

COMBINATION DRIFT AND CHISEL

This hammer is similar to Type CB, but does not have the wire brush. The heads of both hammers are made of high-grade tool steel, heat-treated to withstand severe service.

NEW CIRCULAR

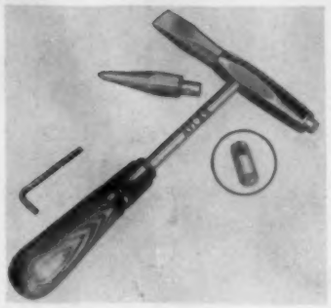
Illustrating the complete CMD line is now ready. Write for your FREE copy Now!

CHICAGO MANUFACTURING AND DISTRIBUTING COMPANY

Dept. W., 1928 West 46th St., Chicago, Illinois

Symbol Hammer

★ A new combination "symbol" hammer and weld cleaning tool is just announced by the **Atlas Welding Accessories Co.**, 307 Boulevard Building, Detroit. With this hammer, a mark may be placed permanently in the steel alongside the work done by each weldor. Thus the responsibility for every weld can be definitely placed. Interchangeable marking tips are available in enough symbols to provide individual identification for crews up to 20,000 men. The hammer is combined with a weld cleaning tool with replaceable bits. Illustration shows chisel, pointed bit for close corner work and socket wrench for turning socket head screw to replace bits and symbols.



Weld identification can be definitely provided with this new-type symbol marker and weld cleaning tool.

» «

A-C Welders

★ A new line of **heavy-duty A-C welders** for single, dual and multi-operation in sizes 300, 400, 500, 800, 1,000 and 1,200 amp, 220, 440 and 550 volts, is announced by **Larkin Lectro Products Corp.**, 220 Taaffe Place, Brooklyn. Features are new, exclusively designed transformer construction and continuous "Glide-Control" amperage adjustment by means of a calibrated scale. All models are mounted on casters; those from 500 amp up are also equipped with eye-bolts for lifting by crane. Built-in capacitors for power factor correction are available if desired.

Larkin A-C welders are now available from 300 to 1,200 amp for heavy-duty welding. "Glide-Control" amperage adjustment is featured.

» «

Carrier Frames

★ These newly introduced **steel carrier frames** may be provided with wooden liners (inserts) for storing and protecting finely machined and highly finished parts and tools. The frame itself has no bottom, its side walls being formed into a channel-shape to hold the wood insert in position. At each corner, the frame is fitted with a heavy steel lug attached with eight projection welds. These lugs permit several frames to be fastened or stacked together into one rigid unit.

The frames are made in two sizes: 30 by 20 by 5¾ in. and 30 by 30 by 3¾ in. The wood inserts are supplied by the user to meet his own requirements. Either carriers with partitions, carriers with holes or carriers with pegs may be used. With partition-type inserts, 679 space sizes are said to be possible.

For further information, write **Lyon Metal Products Co.**, 3177 Clark St., Aurora, Ill.

THE NAVY TAKES "JAVA"

hot out of urns brazed with EASY-FLO!

YES, Easy-Flo's contribution to the war effort extends even to the making of coffee urns for the Navy. Above you see some large Monel urns in the making. Bottoms are brazed to the shell with Easy-Flo and the tops are brazed to a reinforcing ring.

Easy-Flo also helps to make other equipment essential to the health and comfort of our fighting men, including field kitchens, cook stoves, food refrigerators, air conditioners and the like.

And when it comes to fighting equipment, this low temperature silver brazing alloy is doing hundreds of metal joining jobs involved in making planes, ships, tanks, guns and shells.

To all this wide variety of work Easy-Flo brings the exceptional speed with reliability and economy that made it a leader before the war, among brazing alloys used by industry.

If your war effort includes the joining of ferrous, non-ferrous or dissimilar metals, particularly where joints must be strong and leak-tight, step up your production with Easy-Flo. We'll be glad to help you get started.

GET FULL DETAILS IN BULLETIN 12

This bulletin gives you the reasons for the speed, reliability and economy of Easy-Flo brazing and shows you how easy it is to put this free-flowing, fast-acting alloy to work in your plant. Also contains much useful information about joint designs, heating methods and production procedures. Write for a copy of Bulletin 12 today.

HANDY & HARMAN
82 Fulton Street New York, N. Y.
Bridgeport, Conn. · Chicago, Ill. · Providence, R. I. · Toronto, Canada

ARMY E NAVY

A-C Welder

★ **Model "G" A-C welder** is designed for general welding purposes and will operate on either 220 or 440 volts. It has a welding capacity of from 30 to 300 amp and can be operated continuously at 225 amp. The Bakelite operating panel is mounted on top of the machine. By turning the crank, the current can be controlled for any gradation of welding heat between minimum and maximum output.

Hampton portable A-C arc welder. It will handle electrodes from 1/16 to 1/4 in. inclusive and can be used for horizontal, vertical or overhead welding.

A thermostatically controlled automatic cut-out switch protects against excessive overloads, and a stabilizer in the welding circuit controls and balances the voltage and current across the arc. Decreased spatter, assurance of homogeneous welds, no magnetic blow, no dead spots and instant striking of an arc are other advantages claimed for this machine.

Dimensions are 16½ by 23½ by 28 in. high; weight, 325 lb. The welder is mounted on large ball-bearing castors and is furnished complete with ground cable, electrode cable and electrode holder. A catalog giving complete specifications is available from the **Hampton Electric Mfg. Co.**, 300 Archie St., Oakmont, Pittsburgh, Pa.

» «

Leather Clothing

★ This line of weldors' **protective clothing** includes a coat, gloves, mittens, pants, cape sleeve with detachable apron and overalls. The garments are made of chrome leather, tanned to manufacturer's specifications in order that it may be soft, pliable and resistant to wear and heat. This leather is washable with warm water and a mild toilet soap. Heavily coppered rivets are used to eliminate rusting and also a quality grade of snaps, buttons and zippers.

Clothing designs, states manufacturer, are often suggested by weldors, and the first models are thoroughly tested by weldors under all conditions before mass production is undertaken. **Singer Leather Clothing Co.**, 129 North Twelfth St., Philadelphia.

A
Sensational
WELDING
DEVELOPMENT
by
AGILE
★ SILVER-RED ★
ELECTRODES
build up lasting cutting edges on medium and low carbon steels. They give maximum satisfaction when used in the salvaging or manufacture of cutting edges that encounter high abrasion.
★ SILVER-GREEN ★
ELECTRODES
produce a steel recommended as the toughest and strongest steel for forming tools, for building new or salvaging old dies of all types, for shear blades, chisels, etc.
SEND FOR THE LITERATURE TODAY!
AGILE ACTARC
AMERICAN AGILE
Corporation
5806 HOUGH AVE. · CLEVELAND, OHIO

Cast Iron Welding Electrode

★ An all-ferrous electrode, **Castolin eutectic alloy No. 24B,** has just been introduced for arc welding cast iron. The rod is said to have exactly the same color as cast iron and also the same chemical and physical properties. Its metallurgical composition, together with that of the coating, is stated to insure a machinable weld provided that directions are carefully followed. For obtaining a perfect result, it is necessary to preheat broadly and deeply around the spot to be welded at between 300 and 800 F. Some castings should also be stress relieved after welding and allowed to cool slowly.

The tensile strength of No. 24B varies between 29,000 and 38,500 psi. Its hardness is between 200 to 265 Brinell. Welds produced with this electrode are said to be corrosion and heat resistant and to permit galvanizing or enameling over the welded surface. **Eutectic Welding Alloys Co.,** 40 Worth St., New York, N. Y.

» «

Dust Respirator

★ **MSA Comfo dust respirator** has been redesigned with filter cases of black plastic, which are thin discs with rounded edges. The new filter container

Dust protector. This new plastic model has twin replaceable filters of unusually large area.

units are said to offer less resistance to air flow and to permit better sidewise and downward vision. They are also said to possess high impact strength, to be without electrical conductivity and to remain unaffected by perspiration. Previous advantages of safety and comfort in dust protection are retained.

These respirators are available in a number of types to meet various dust and mist conditions. **Mine Safety Appliance Co.,** Braddock, Thomas and Meade Streets, Pittsburgh.

» «

Spot Weld Tester

★ A testing machine for checking the strength of spot welded factory samples has recently been developed by **The Baldwin Southwark Div.** of The Baldwin Locomotive Works, Philadelphia. It is a motor-driven hydraulic machine with an overall height of 70 in. and a total weight of 800 lb. Open face grips accommodate offsets in welded specimens from the smallest gauge to ¼ in. thickness. The grips are self aligning, lever operated and have renewable hard file faces. No backing plates or liners are needed. Hand moving of this machine is facilitated by its 18 in. diam base and low center of gravity, but a hoisting hood at the top permits crane handling. Cylinders with a 2 in. stroke are set in the top section, and the top and bottom handling levers are set at right angles for convenient operation.

Spot weld testing machine. Load is indicated on the 8 in. precision dial on top.

BOOST PRODUCTION
ON ALL GRINDING
AND SANDING WITH
SKILSAW
SANDER-GRINDER
MODEL "SL"
• SKILSAW Model "G" DISC SANDER swiftly grinds down raised welds. Also cleans metals, files, buffs and polishes.
• SKILSAW Model "P" DISC SANDER smooths down welding beads. Speeds all sanding on flat or curved surfaces.
Want to grind hours off production schedules in your shop? Put SKILSAW MODEL "SL" SANDER-GRINDER to work on all your surfacing. It's light in weight, but rugged and powerful for easy, top-speed operation . . . grinding down welds, cleaning metals, filing, sanding, polishing, rubbing and buffing . . . for biggest time savings on every job!
SKILSAW MODEL "SL" SANDER-GRINDER is typical of the entire line of SKILSAW DISC SANDERS. 6 Powerful Models . . . light, compact, perfectly balanced for easier handling and greater speed on every surfacing or finishing job. Ask your distributor for a demonstration.
SKILSAW, INC., 4763 Winnemac Ave., Chicago
New York • Boston • Buffalo • Philadelphia • Cleveland
Detroit • Indianapolis • St. Louis • Kansas City • Atlanta
New Orleans • Dallas • Los Angeles • Oakland • Portland
Seattle • Toronto, Canada
SKILSAW PORTABLE ELECTRIC TOOLS
★ MAKE AMERICA'S HANDS MORE PRODUCTIVE ★

No. 254 women's helmet with snood.

Women's Helmets

★ **Sellstrom Mfg. Co.**, 626-10 N. Aberdeen St., Chicago, has announced two new welding helmets designed to provide protection for the ever increasing number of women weldors. These models, **Nos. 254** and **245**, are made of toughened fibre in the rounded-front style. Tops and bottoms curve inwardly to shield the top of head and neck. The helmets are said to be shockproof and also roomy enough to provide ample ventilation and free movement of the weldor's head. Model 254 (illustrated) has been provided with a snood of lightweight, closely woven fabric to give additional protection to the hair and head.

» «

Acme transformer. It was designed for a special war production job.

Welding Transformer

★ **Acme Electric & Mfg. Co.**, Cuba, N. Y., announces the development of a special welding transformer for operation on primary circuits of 115 volts, single phase, 60 cycles. This transformer has secondary characteristics of 0.75 volt, 1,600 amp.

» «

Multiple Angle Drill

★ This lightweight rotary drill features a drilling head which can be set at any angle through 360 deg. The head can also be turned to any position relative to the location of the throttle lever. This design permits the operator's fingers to be brought close to the point of application. The tool weighs 2½ lb., is about 8 in. long and has a 3-jaw chuck

(Advertisement)

Amsco V-Mang Makes Cutter Head "Good as New at Half the Cost"

Restoring a broken and worn cutter head for a 12″ hydraulic dredge to a condition "as good as new and at half the cost" was accomplished by the Iowa State Conservation Commission at Storm Lake, Iowa through the use of Amsco V-Mang and Amsco No. 459 Hard Surfacing Welding Rods.

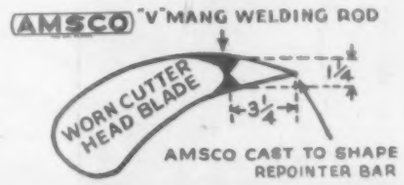
This cutter head was broken across the back rim, three tie braces were broken loose from the cutter blades, while the blades were worn to a minimum width of 3″—in fact, the cutter head was useless in its deteriorated condition.

To rebuild the cutter head, cast dipper tooth repointer bars were welded to the worn blades with Amsco V-Mang; and following this operation, the cutting edge of the bars, or blades, was hard surfaced with Amsco No. 459 Hard Surfacing Material.

A careful tabulation of cost of time and materials, including hauling, electric current, etc., came to $621.70.

"*Estimated cost of a new cutter head was $1,200.00, but owing to war conditions, it was impossible to secure a new one. The work of rebuilding was done in our own shop by one of our own men. In our opinion, the rebuilt head is now equal to a new one and at approximately half the cost,*" writes J. A. Dunkel, Superintendent of Dredging, Storm Lake, Iowa.

With all-out war production preventing the replacement of much-needed equipment, you, too, can rebuild worn or broken construction, dredging or quarrying equipment parts, quickly and economically, with Amsco Welding Rods. Write for Bulletin 941-W containing money-saving application suggestions.



Above: before reclamation. Below: after building-up and hard-facing.

Amsco
AMERICAN MANGANESE STEEL DIVISION
OF THE AMERICAN BRAKE SHOE & FOUNDRY CO.
Chicago Heights, Illinois

Manganese Steel Castings for shocks and abrasion.
Chromium-Nickel Alloy Castings for heat and corrosion resistance.
Power Shovel Dippers. Dredge and Industrial Pumps.
Welding Materials for reclamation and hard-surfacing.

FOUNDRIES AT CHICAGO HEIGHTS, ILL.; NEW CASTLE, DEL.; DENVER, COLO.; OAKLAND, CALIF.; LOS ANGELES, CALIF.; ST. LOUIS, MO. OFFICES IN PRINCIPAL CITIES

for shanks from ⅛ to ¾ in. Available in speeds of 1,000 rpm., **No. 9D010**, and of 2,000 rpm., **No. 9D020**. A spanner, end wrench and hexagon wrench are furnished with drill. **The Cleveland Pneumatic Tool Co.**, Marble Ave. and East 77th St., Cleveland.

Cleco drill. Holes may be drilled at any angle of 360 deg circle. Head also swivels in two planes.

News of the Industry

Glenn-Roberts Opens Indiana Branch Plant

A new branch factory to care for eastern and midwestern customers has recently been opened by **Glenn-Roberts Co.** at 2107 Adams St., Indianapolis. The company's sales headquarters have been moved from Chicago to the new plant, which contains complete facilities for servicing G-R manual and automatic A-C arc welders. Shipments to points east of the Mississippi River are now made from Indianapolis instead of from the company's main plant at Oakland, Calif.

» «

Prizes in War Bonds for Salvage Methods

Metallizing Engineering Co., Inc., is offering a total of $650 in War Bonds as prizes for details of maintenance and salvage procedures with the metal spraying process. The prizes are: first, $250; second, $150; third, $100; and three prizes of $50 each. The contest closes Dec. 15. Those interested should write for entry forms to *Metco News*, 21-07 41st Ave., Long Island City, N. Y.

» «

Lessons in Grinding Taught by Movie Film

To meet the demand for training information on grinding for the host of "apprentices" who are now working in war plants, **Norton Co.**, Worcester, Mass., has produced a series of four pictures entitled "Lessons in Grinding." These training films are now ready for distribution and are available to industrial apprentice schools, Army and Navy training schools and all other classes where machine shop practice is taught. Projection times range from 14 to 20 min.

The subjects covered are: No. 1, "Cutter Sharpening"; No. 2, "The Cylindrical Grinder"; No. 3, "The Surface Grinder"; No. 4, "The Grinding Wheel, Its Care and Use."

» «

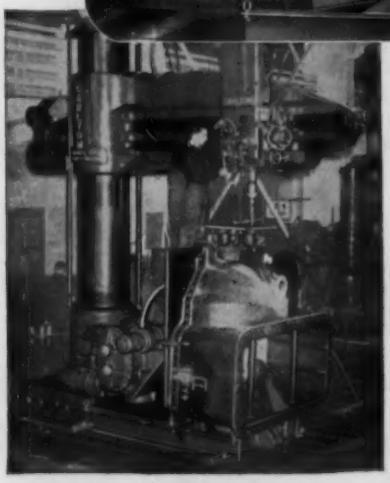
Pneumatic Tool Changes Branch Office Addresses

The **Independent Pneumatic Tool Co.**, Chicago, announces new locations of its branch offices at Boston and Birmingham and the appointment of a new Boston branch manager. The Boston office, now managed by **Vance G. Turner**, has moved to 78 Brookline Ave., and the Birmingham office has moved to 1411 North Third Ave.

» «

Moves to New Quarters

The **Grobet File Co. of America**, distributor of Swiss pattern files and rotary files, has removed to larger quarters at 421 Canal St., New York City.



(1) Drilling Angle Hole on side and (2) by tilting Positioner 90° and revolving table, "straight" holes are drilled on all 4 sides and in top.

One Set-up on a C-F Positioner

—permits drilling from all sides, at any angle

Designed to revolve and tilt weldments so that all sides can be welded "down hand," C-F Positioners are today being used not only for welding, but for holding and positioning work for many different machining operations. Coming in sizes and capacities to carry work weighing up to 30,000 lbs., adjustable for height and capable of turning or rotating work completely around and tilting it at any angle (up to 135° off horizontal), these versatile positioners are reducing the number of set-ups required for many jobs.

Write for Bulletin WP 22 showing C-F Positioners as used to permit down hand welding on all surfaces of weldment with one set-up.

CULLEN-FRIESTEDT CO.,
7309 S. KILBOURN AVE. CHICAGO, ILLINOIS

ASA Revises Standard for Pressure Piping

Approval of the 1942 revision of the American Standard, **"Code for Pressure Piping"** (B31.1) was announced last month by the **American Standards Association,** 29 West 39th St., New York City. The standard and supplementary information has been published as a 32-page, 9 by 12 in. pamphlet.

The piping code was first approved in 1935. The revised edition covers power piping, gas and air piping, oil piping, district heating piping, refrigeration piping, fabrication details, and materials and identification.

» «

Two New P&H Agents Named for Wisconsin

Wisconsin Auto Supply Co., Wausau, and **W. H. Hobbs Supply Co.,** Eau Claire, Wisc., have been appointed agents on an open basis for P&H Hansen electric arc welders and P&H welding electrodes, manufactured by the **Harnischfeger Corp.,** Milwaukee.

» «

Tool Salvage Film Emphasizes Brazing

"Save Those Tools," a one-reel sound motion picture, is now released for showings by the **International Harvester Co.** This film, produced at the suggestion of the Conservation Division, Industrial Salvage Section, WPB, shows how the Harvester Company's tool salvage program was organized and its methods of functioning from individual plants to the central clearing house. Emphasis is given to the low temperature brazing process as a means of repairing broken or damaged tools.

Prints, in either 35 or 16 mm sizes, are available at no charge other than for transportation. Address requests to International Harvester Co., 180 North Michigan Ave., Chicago.

ABOUT PEOPLE

Those in our nation's armed forces may continue to read THE WELDING ENGINEER at a special reduced price of $1.50 per year for the duration.

» «

Twenty-one old-timers of the **Victor Equipment Co.,** San Francisco, recently got together in order to stage a surprise dinner in honor of **"Dick" Heinemann,** general plant superintendent. Heinemann, who had just completed his 25th year with the firm, was presented with an engraved wrist watch in appreciation of his loyal service. He came to Victor (then known as the Great Western Welding and Cutting Co.) in 1917. At that time the company's entire personnel consisted of himself, L. W. Stettner, who is now president and chairman of the board of directors, and Fred Kappes, deceased.

» «

George E. **Whitlock** and **A. E. Walker** have been elected to the board of directors of **The American Welding and Mfg. Co.,** Warren, O. Mr. Whitlock is president of The Mullins Mfg. Corp., Warren, and Mr. Walker is president of The National Supply Co., Pittsburgh.

» «

W. L. Davis has been elected a member of the board of directors of **Scully Steel Products Co.,** a subsidiary of United States Steel Corp. Mr. Davis has been manager of operations for the Scully company since Aug. 1, 1942.

The Second Front

A NUMBER of readers have requested information regarding production lost through the 80 million man-hours of labor lost which was mentioned in the editorial, "The Second Front." According to the best available production figures, 80 million man-hours of labor can be converted into 5,000 light tanks, 1,920 fighter planes, 384 Flying Fortresses, 141 Liberty ships, 10 destroyers, nearly 3 aircraft carriers or more than 1 battleship.

MARQUETTE
SUPERB A.C. PERFORMANCE PLUS BIGGER RODS
MAKES FAST FABRICATION FASTER
This will make a PRODUCTION MAN Happy
PROMPT DELIVERY on MARQUETTE RODS

Speed, and more SPEED, is the imperative demand of war-time metal fabrication. Meet this demand by using bigger rods for faster welding speeds, and by using MARQUETTE'S superb welding performance in the deposition of these bigger rods.

19 accurately calibrated amperage stages of this power-packed Industrial Model gives instantaneous heat selection . . . Automatic voltage control delivers perfect welding current at all heat stages for fast, uniform, high quality welds . . . A. C. current and improved, heavy duty, reactance type transformers deliver uninterrupted, smooth flowing welding current and precludes delays due to troublesome "magnetic blow."

BUY MARQUETTE FOR
LOW INITIAL COST . . . LOW COST OPERATION . . . SIMPLE, FAST OPERATION . . . AUTOMATIC VOLTAGE CONTROL . . . ALL-ASBESTOS INSULATION . . . EXTRA STURDY CONSTRUCTION . . . COMPLETELY EQUIPPED . . . FIVE MODELS. 150 to 400 Amps.

Send for free, 24 page, illustrated booklet.
MARQUETTE MFG. CO., INC. MINNEAPOLIS, MINN.

MARQUETTE
REG. U. S. PAT. OFF.
A.C. ARC WELDERS

James E. Vosburgh, associated with the **Glenn-Roberts Co.** of Oakland, Calif., since its establishment in 1934, will now head the staff of the company's new Indianapolis plant (see also page 66) as general manager. **Roy E. Davis,** until recently superintendent at the Oakland factory, has been appointed assistant manager at Indianapolis.

» «

Died . . .

Charles H. Norton, known as the "father of cylindrical grinding," died Oct. 27 in Plainville, Conn., at the age of 91. Mr. Norton became associated with the Norton Co., Worcester, Mass., in 1900, after many years of preliminary experience with the Brown & Sharpe Mfg. Co. and other firms. He was the author of "Principles of Cylindrical Grinding," considered the standard authority on that subject, and the holder of more than 100 patents.

Helpful Literature Just Published

The following reviews are of recent publications of interest to those in the welding industry. Unless otherwise stated, they may be obtained without cost by writing to the manufacturer or to THE WELDING ENGINEER.

Tool Reclamation Booklet

In all probability, broken tools containing high speed steel constitute one of the most critical problems today confronting American industry. Because scarce alloy materials such as tungsten are needed for high speed steels, there exists an alarming shortage of the steel used to make cutters, drills, broaches, reamers, etc. A specialized welding process for tool reclamation and repair is described in a recently published 12-page, 5½ by 8½ in. booklet titled **"The Reclamation of High Speed Steel Tools by Suttonizing . . . a Welding Process."**

The "Suttonizing" process involves the deposition of hard alloy material said to match or excel the original hardness of the tool being welded. It differs from other methods generally used to effect tool reclamation in that, in most cases, subsequent heat treatment is not necessary.

Welding Equipment & Supply Co., 223 Leib St., Detroit, Mich.

» «

Wrought Iron Welding Guide

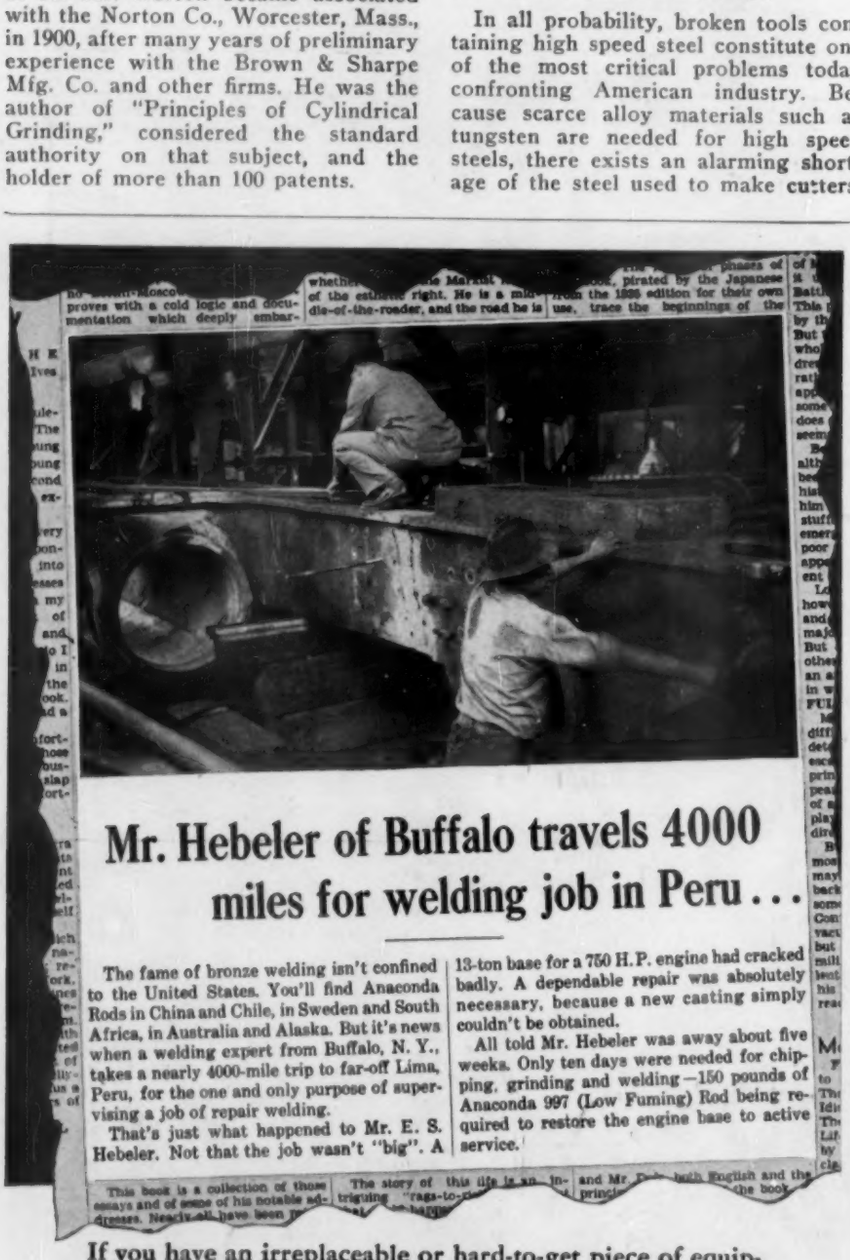
Though wrought iron is unusually easy to weld, it is important to know the proper procedure since wrought iron differs from other weldable ferrous materials in having slag inclusions. The Byers wrought iron **"Ready Reference Weldors' Guide"** should be helpful in this connection. The guide is a chart, 30 by 19¼ in., available free of charge for posting on the wall in the welding shop; it covers both oxy-acetylene and arc welding, giving such information as the type of rod or electrode to use, joint preparation for welding different thicknesses of wrought iron plates, speeds, flame or current conditions, etc.

The wrought iron "ready reference" chart is issued as part of a complete refresher course for weldors, pipe fitters, plumbers and other metal workers handling wrought iron pipes or plates. To date, four wall-type instruction charts and four booklets have been issued, dealing with the subjects of welding, flame-cutting, pipe threading, pipe bending and plate bending. **A. M. Byers Co.,** Pittsburgh, Pa.

» «

"Contribution to Victory"

This is an 8-page, 8½ by 11 in. booklet describing and picturing the use of Ampco metal (a bronze alloy) by various war industries. It is printed in two colors and contains illustrations of war equipment and weapons in which Ampco bronzes are employed. Copies will be sent on request to engineers interested in bronze applications. **Ampco Metal, Inc.,** 1745 South 38th St., Milwaukee.



Mr. Hebeler of Buffalo travels 4000 miles for welding job in Peru . . .

The fame of bronze welding isn't confined to the United States. You'll find Anaconda Rods in China and Chile, in Sweden and South Africa, in Australia and Alaska. But it's news when a welding expert from Buffalo, N. Y., takes a nearly 4000-mile trip to far-off Lima, Peru, for the one and only purpose of supervising a job of repair welding.

That's just what happened to Mr. E. S. Hebeler. Not that the job wasn't "big". A 13-ton base for a 750 H.P. engine had cracked badly. A dependable repair was absolutely necessary, because a new casting simply couldn't be obtained.

All told Mr. Hebeler was away about five weeks. Only ten days were needed for chipping, grinding and welding—150 pounds of Anaconda 997 (Low Fuming) Rod being required to restore the engine base to active service.

If you have an irreplaceable or hard-to-get piece of equipment that at first seems beyond repair, don't scrap it. Investigate the possibilities of bronze repair welding. 4298A

ANACONDA

Anaconda Welding Rods

THE AMERICAN BRASS COMPANY, General Offices: Waterbury, Connecticut

Subsidiary of Anaconda Copper Mining Co. • In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

Tweco Catalog

"Tweco Products Have Gone to War!!" is the title of a new 8-page, letterhead-size catalog just issued by **Tweco Products Co.,** English at Ida, Wichita, Kansas. Tweco products, it is stated, are now being used in shipyards, aircraft and tank plants and arsenals. The catalog covers the complete Tweco line of ground clamps, insulated and plain electrode holders, mechanical cable lugs, mechanical and solder detachable cable connectors. Several new models of electrode holders and cable connectors are described.

» «

Stud Welding Gun Bulletin

A new arc welding process and its equipment are described in detail in, **"National Stud Welding Process,"** a 4-page, letterhead-size bulletin just published by **Hollup Corp.,** Div. of National Cylinder Gas Co., 4700 West 19th St., Chicago. The equipment includes a stud welding gun and control cabinet which are now being used in many shipyards for fastening wooden planking to metal decks. See page 42, this issue.

» «

Sciaky Catalog

Sciaky's new **P-1-R catalog** is devoted to just one product—the Sciaky P-1-R portable radial spot welder (see page 60, THE WELDING ENGINEER, September, 1942). The catalog describing this new product is a two-color, 11 by 8½ in., 20-page spirally bound booklet, which contains a large number of photographic illustrations as well as scale drawings and specifications of working parts. Operation of this welding gun is described in detail, and charts and other data pertaining to the spot welding of stainless steel are included.

Sciaky Bros., 4915 West 67th St., Chicago.

» «

Pipe Fitting Catalog

Bonney Forge & Tool Works, Allentown, Pa., has just issued a 16-page, two-color, 8½ by 11 in., booklet, **Bulletin WT31,** which tells how to make welded branch pipe outlets. Three different types of welded pipe fittings are described—Bonney "WeldOlets," "ThreadOlets" and "Socket-End WeldOlets"—each of which is designed for a particular application. With these stock fittings, it is possible to make right-angle branch pipe outlets such as tees, crosses, side outlets, etc., by welding.

» «

IAA Publication

A revised edition (third) of **"Safe Practices for Installation and Operation of Oxy-Acetylene Welding and Cutting Equipment"** is now available at 25c per copy from the **International Acetylene Association,** 30 East 42nd St., New York. This is a 64-page, 6 by 9 in. booklet containing material compiled and presented by the Oxy-Acetylene Committee of IAA. Among the subjects discussed are eye protection, safe clothing, fire prevention, accident prevention, industrial health, precautions for the storage and use of cylinders, torch connections and adjustments, etc.

» «

Hard-Facing Folder

A 6-page, 3½ by 6½ in. folder on Resisto-Loy and Isorod hard-facing alloys may be obtained by addressing **The Resisto-Loy Co.,** Grand Rapids, Mich. The folder gives instructions for using these alloys with both oxy-acetylene and arc (D-C and A-C) welding processes.

"Men and Machines"

L. O. Koven & Brother, Inc., 154 Ogden Ave., Jersey City, N. J., has published a 16-page, two-color, letterhead-size brochure titled, **"Koven Men and Machines for War Work."** This presents a pictorial exhibit of the facilities, equipment and trained workers which Koven is offering in metal fabricating for both prime and sub-contract war production. Of special interest is the welding shop where 37 D-C welders from 100 to 600 amp are available. Other equipment includes A-C welders up to 500 amp, automatic welders of various types, flame-cutting machines and welding positioners.

Victory in Sight
● Victory is won on production fronts too—Dockson Eye and Face protection is *preventing* costly injuries to workmen—workmen who must *stay on the job* if victory is to be ours.
DOCKSON CORPORATION
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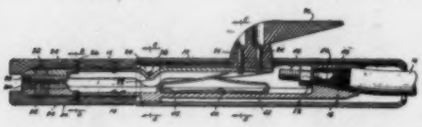
FROM THE PATENT OFFICE

Electrode Holder

2,300,295. **Honel A. Jackson,** Detroit. Filed Feb. 27, 1941. Issued Oct. 27, 1942.



An electrode holder, elements of which are a pair of jaw-holding members assembled together in generally parallel side-by side relation. The members are channel-shaped in cross-section throughout the major portions of their lengths and are arranged with the channels facing toward one another and the channel side walls in line with one another. A hollow, open-ended, substantially cylindrical case of insulating material encloses the end sections of the members opposite the jaws for gripping the electrode. Inside the case, one of the members is provided with a U-shaped bend, which projects toward the other member and forms a saddle-like depression on the opposite side thereof. At the U-shaped bend, the side walls forming the channel bear on the side walls of the channel of the other member and, by virtue of the U-shape of the bend, form a rocking fulcrum. A pin extends across the saddlelike depression and is connected to the side portions in order to hold the members against longitudinal displacement with respect to one another while permitting rocking of one member with respect to the other. Inside the case, a spring between the members urges their inside sections away from one another.

» «

Welding Jig

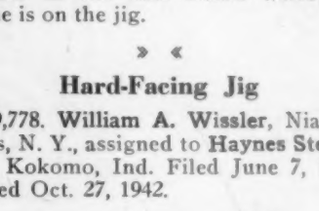
2,299,753. **George C. Johnson** and **Harry S. Boles, Chicago,** assigned **Pullman-Standard Car Mfg. Co.,** Chicago. Filed April 19, 1940. Issued Oct. 27, 1942.

A welding jig for supporting a side of a vehicle in a vertical position while the vehicle frame and sheathing are being welded. The jig comprises a rigid back plate which may be supported firmly in a vertical position, an intermediate plate secured to the face of the back plate, and a copper plate, one face of which is mounted against the outer face of the intermediate plate. Intermediate and copper plates are substantially coextensive with the back plate. Clamps at top and bottom hold the side sheathing and frame in place against the copper plate. At the bottom of the jig is a means adjustable to the degree of camber in the side frame and adapted to hold the camber in the side frame while the frame is on the jig.

» «

Hard-Facing Jig

2,299,778. **William A. Wissler,** Niagara Falls, N. Y., assigned to **Haynes Stellite Co.,** Kokomo, Ind. Filed June 7, 1939. Issued Oct. 27, 1942.



This patent pertains to a device and method for decreasing the distortion which would normally occur when a hot body of hard-facing metal is deposited on the edge of a cooler blade. The blade is subjected, without bending, to a tensile stress during the hard-facing operation; upon its release, it shortens to substantially the same extent as the hot metal is contracted by cooling to ordinary temperatures.

» «

Brazing Flux

2,296,442. **Oskar Horowitz,** Brooklyn, assigned to **Albert I. Elias,** New York City. Filed Feb. 23, 1940. Issued Sept. 22, 1942. A brazing flux comprising an alkali borate, an alkali acid fluoride, halogenides of cadmium and copper, and halogenides of alkali metals.

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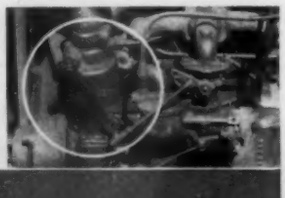
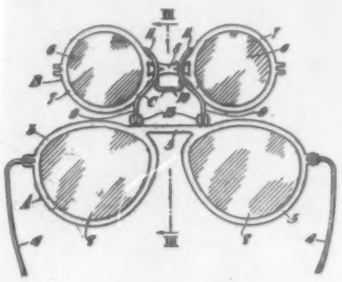
On this motor a direct driving outlet has been provided for the governor. On motors where no driving outlet is provided the governor can be mounted to drive from the fan belt.



Pierce Governors

Safety Glasses

2,300,364. **Charles L. Wagner,** Pittsburgh. Filed Dec. 23, 1940. Issued Oct. 27, 1942.



The safety glasses described in this patent have a clip for removably mounting a second pair of glasses, which may be used for optical correction. The clip is frictionally hinged to the first glasses at the top of the nose portion and is rotated transversely of the first glasses; clip has a terminal resilient gripping portion for receiving and securing the nosepiece of the second glasses.

» «

Safety Goggles

2,300,365. **Charles L. Wagner,** Pittsburgh. Filed March 28, 1941. Issued Oct. 27, 1942.

Included in this patent for safety goggles are a pair of lens frames, heat insulating pads of pliant material disposed about and secured to the frames, and a nose shield which is likewise of heat insulating pliant material. The nose shield includes a band of fine wire gauze, disposed on the outer surface of the shield between the frames and extending downwardly to the point of substantial divergence of the lens frames from the nose.

» «

Spot Welding Gun

2,300,172. **Henry Thomas Platz,** Detroit, assigned to **Briggs Mfg. Co.,** Detroit. Filed Dec. 9, 1935. Issued Oct. 27, 1942.

This patent covers frame, cylinder and piston of a spot welding gun as well as coöperating electrodes respectively carried by the piston and cylinder, both of which are supported on the frame for relative movement in opposite directions. The means for electrically connecting the electrodes includes a jumper bar carried by the frame and shunting the cylinder and piston.

» «

Spot Welding Electrode Dresser

2,300,173. **Henry Thomas Platz,** Detroit, assigned to **Briggs Mfg. Co., Detroit.** Filed Dec. 2, 1940. Issued Oct. 27, 1942.

A tool for reshaping the adjacent end portions of a pair of axially aligned spot welding electrodes. Axially spaced revoluble members, supported for relative movement toward and away from each other, are, in the retracted positions, inserted between the adjacent ends of the electrodes. The work performing surfaces on the revoluble members enter into frictional engagement with the adjacent ends of the electrodes, and the members are then rotated relative to the electrodes in order to reshape the adjacent end portions of the latter.

» «

Multiple Spot Welder

2,299,776. **William A. Weightman,** Philadelphia, assigned to **Edward G. Budd Mfg. Co.,** Philadelphia. Filed June 25, 1938. Issued Oct. 27, 1942.

This patent pertains to a spot welding machine tool having a pair of opposed electrode dies, means for intermittently moving the work between them, a reversible fluid motor means for moving the dies in and out of clamping relation with the work, and other means for intermittently moving the dies out of clamping relation with the work against the force of the motor. Patent also covers the pair of opposed platen electrode dies, the means for feeding a pair of metallic cover sheets and an intervening metallic spacing member between the dies, and the means for maintaining the cover sheets out of electrical contact with the spacing member. The last-mentioned means is situated on the entering side of the dies, between the spacing member and the cover sheets.

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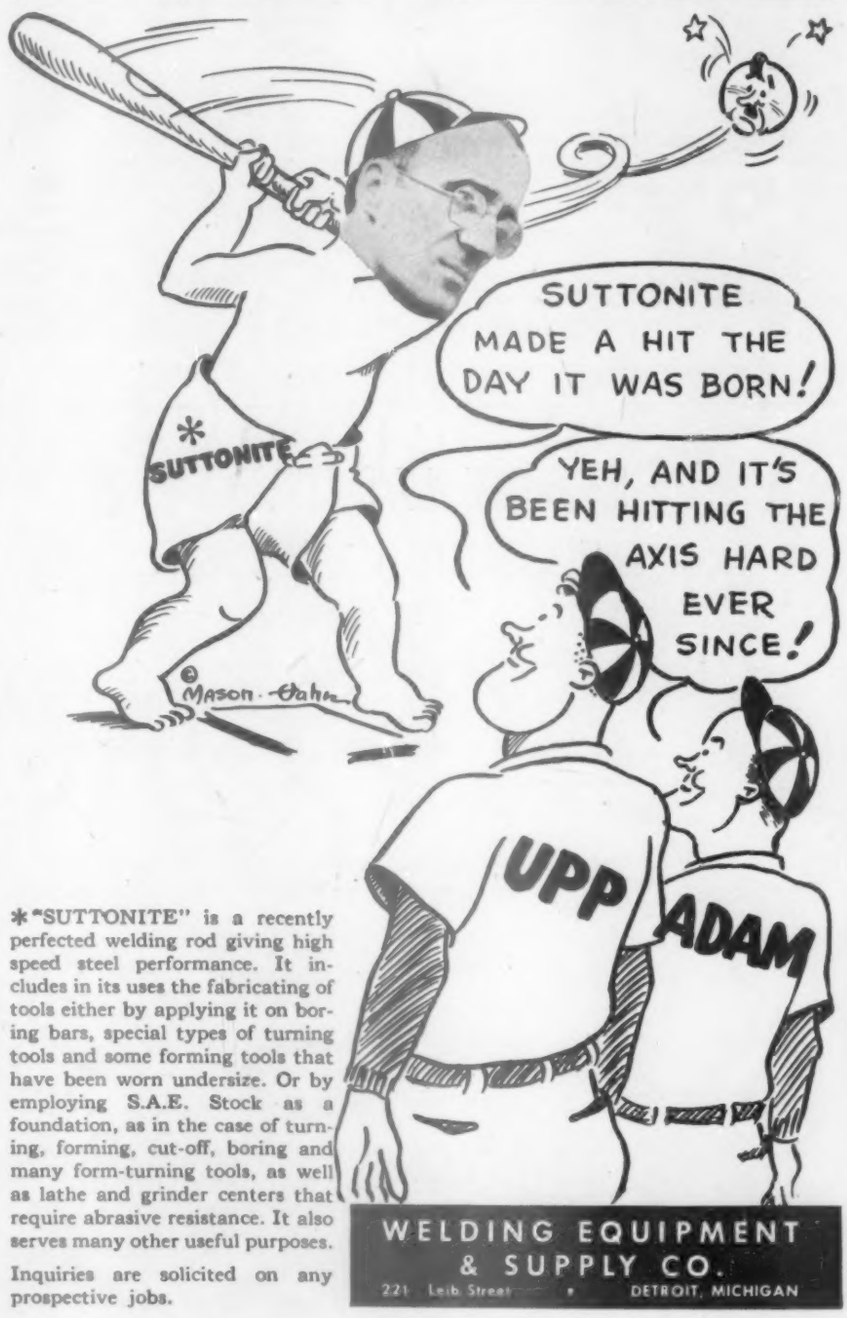

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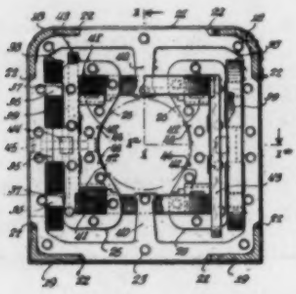
Arc Welding Generator

2,300,732. **William J. Oesterlein** and **Karl A. Blind**, Milwaukee, assigned to **Harnischfeger Corp.**, Milwaukee. Filed April 19, 1939. Issued Nov. 3, 1942.



This patent pertains to a D-C generator for arc welding current supply. Elements are a polygonal field frame composed of superimposed laminations, interpoles projecting inwardly from alternate sides of the polygonal frame, and field pole-pieces which also project inwardly from the remaining sides of the field frame. The pole-pieces comprise an intermediate portion having a central area of low reluctance contact with the field frame and lateral portions disposed on either side and spaced in high reluctance contact with the field frame in order to provide an aperture for windings on either side of the central area. An armature and commutator are rotatably mounted within the field frame in magnetic relation to the pole-pieces and interpoles.

» «

Multiple Spot Welder

2,300,656. **Frank Anthony Doll**, Detroit, assigned to **General Motors Corp.** Filed Jan 2, 1940. Issued Nov. 3, 1942.

This patent pertains to the combination of a multiplicity of spot welding electrodes which all contact the work at the same time. Separate transformers serve designated groups of electrodes, and a means is provided for dividing the electrodes into sub-groups which are successively served by one transformer.

» «

Spot Welder

2,300,700. **Burke Porter** and **Joseph A. Potchen**, Grand Rapids, Mich. Filed Jan. 15, 1940. Issued Nov. 3, 1942.

This spot welding machine has a transformer core provided with a primary coil winding and a U-shaped member, electro-inductively disposed relative to the core, forming a portion of a secondary. The legs of the U-shaped member each have an electrode within an A-C circuit of commercial frequency range; the electrodes are adapted to contact the same surface of one of two pieces of work to be welded together. A portion of the primary coil is spaced diametrically opposite to that portion of the work lying between the electrodes.

» «

Arc Welding Generator

2,300,867. **John H. Blankenbuehler**, Edgewood, Pa., assigned to **Westinghouse Electric & Mfg. Co.**, East Pittsburgh. Filed July 24, 1941. Issued Nov. 3, 1942.

A generator comprising a frame structure, an armature, a field pole positioned in the frame structure, and an additional field pole positioned in the frame structure in opposed relation. The first-mentioned field pole has an arcuate shoe portion adjacent the armature and a body portion with a series field winding thereon; the body portion has a relatively large cross section so as to remain unsaturated under a wide range of load conditions. Leakage poles are positioned adjacent this field pole member to provide a path for leakage flux linking the series field winding. The

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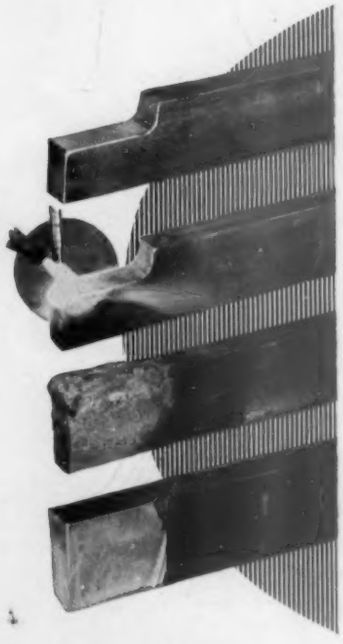

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second-mentioned field pole also has a body portion with a series field winding thereon; this body portion, however, has a relatively small cross-section so as to be saturated under substantially all load conditions.

» «

Tube Welding Method

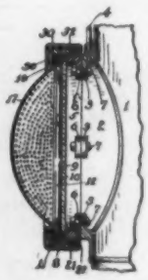
2,300,850. **Darwin S. Wolcott,** Colonial Village, Pa., assigned to **Lukens Steel Co.,** Coatesville, Pa. Filed June 13, 1939. Issued Nov. 3, 1942.

A method of producing corrosion-resistant tubing from sheets of steel and corrosion-resisting material integrally united to form a laminated strip. This strip, which has a width somewhat in excess of the circumference of the required tube, is shaped to the form of a tubular blank with the cladding material outside. The edges are then heated to welding temperature and forced together to produce a weld of the body sheet. The welding pressure causes extrusion of some steel through the cladding material at the joint; this extruded steel is removed to a depth at least as great as the thickness of the cladding, and fused metal identical with the cladding is deposited along the joint.

» «

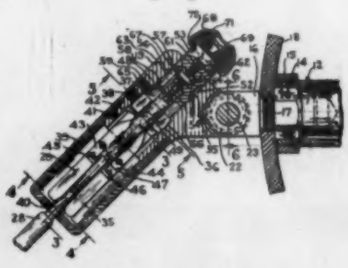
Lens Assembly for Helmet

2,301,018. **John F. Clark,** Wyomissing, Pa., assigned to **Willson Products, Inc.,** Reading Pa. Filed Dec. 10, 1941. Issued Nov. 3, 1942.



An encircling lens-holding frame for the sight opening of a protective helmet. Elements are an annular outer edge seat, an exterior locking rib, a lens-protecting screen seated on the edge seat, and a shock-absorbing cap of flexible material. Cap has a flange portion adapted to hold screen to its edge seat and a ring portion with an interior recess adapted to engage frame and lockingly engage the frame locking rib.

» «



Electrode Holder

2,301,108. **Jack Churchward,** New Haven, Conn., assigned one half to **Myrlon A. Farnham,** New Haven. Filed Aug. 27, 1941. Issued Nov. 3, 1942.

An electrode holder having opposed jaws, biased toward each other to grip an electrode, and a means movable lengthwise of the jaws to spread jaws apart to release electrode and to engage an end of the electrode to eject it from between the jaws.

» «

Chain Welding Machine

2,301,173. **Gustave K. Blum** and **Arthur E. Peters,** York, Pa., assigned to **The McKay Co.,** Pittsburgh. Filed Feb. 11, 1938. Issued Nov. 10, 1942.

A chain welding machine having a pair of electrode-carrying blocks mounted to turn about a pair of substantially parallel axes. The blocks are turned through a limited angle about another pair of axes approximately normal to the first pair.

» «

Flame-Cutting Apparatus

2,301,923. **Roger S. Babcock,** Plainfield, N. J., assigned to **The Linde Air Products Co.** Filed June 8, 1940. Issued Nov. 17, 1942.

Apparatus for controlling the molten slag which emerges from a kerf formed during a flame-cutting operation. The work being cut is supported by a pair of chill members adjacent opposite edges of the kerf; the chill members are arranged in spaced divergent relation to provide a channel for receiving the molten slag as it emerges from the kerf.

» «

Radiographic Method

2,302,470. **Charles Pecher,** Berkeley, Calif., assigned to **Research Corp., New York City.** A method of producing industrial radiographs of relatively thick metal objects. A radiation-sensitive surface is placed on one side of the object and the other side exposed to strong, substantially monochromatic gamma radiation from radioactive yttrium 86. The latter substance is produced by deuteron bombardment of strontium and compacted to a minimum practical source volume.

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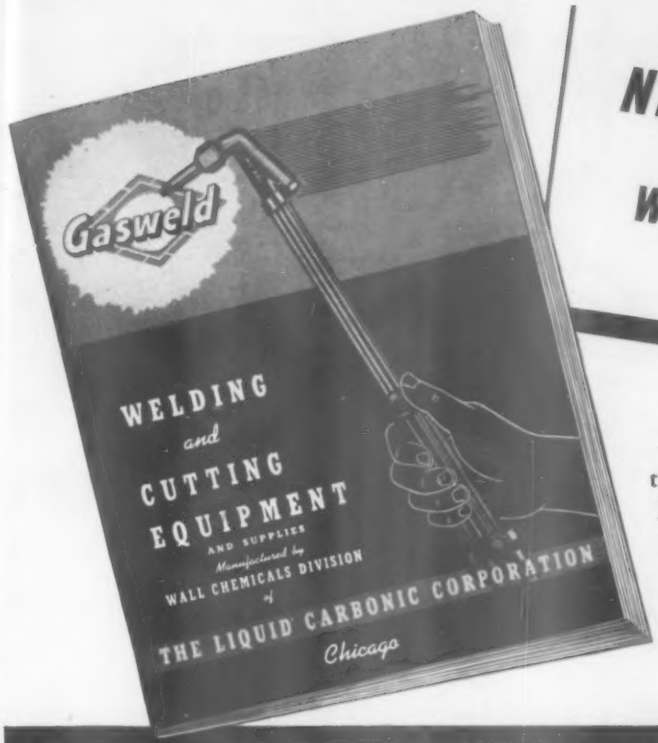

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Spot Welding Circuit

2,302,119. **Gerhard Hagedorn**, Berlin-Halensee, Germany; vested in the **Alien Property Custodian.** Filed Sept. 13, 1939. Issued Nov. 17, 1942.

This patent pertains to a spot welding apparatus having a transformer with primary and secondary winding, a generator with field winding, a load circuit including the secondary winding, a primary circuit including a switch for impressing the generator voltage across the primary winding, means for exciting the field winding of generator, means (including a switch) for short circuiting the primary winding, and means for eliminating the field exciting means of generator when the switch for short circuiting the primary winding is closed.

» «

Tube Mill

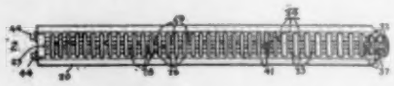
2,302,163. **James L. Anderson**, Closter, N. J., assigned to **Air Reduction Co., Inc.**, New York City. Filed April 24, 1940. Issued Nov. 17, 1942.

A method of making a welded tube of uniform wall thickness and homogeneous section. The edge faces of a longitudinal seam of a moving tube blank are heated progressively along the length of the seam with the edge faces separated; the heating is done by jets projected directly against the edge faces to heat them quickly across their full width. Immediately after heating, the edge faces are forced together with sufficient pressure to squeeze out any consequential amount of metal fused by the heating. As the welded tube moves beyond the region of welding, a mechanical cutter removes the squeezed-out metal in order to reduce the wall thickness at the weld to the same thickness as the rest of the tube.

» «

Multi-Flame Torch

2,302,164. **James L. Anderson**, Closter, N. J., assigned to **Air Reduction Co., Inc.**, New York City. Filed May 17, 1940. Issued Nov. 17, 1942.



Elements of the welding torch described in this patent are an elongated block, a lengthwise extending recess in each side of the block, a cover closing each recess to form a distributing chamber, a means for supplying a fuel-gas mixture to each of the distributing chambers and a channel with diverging side walls extending lengthwise in one face of the block. Flame jet orifices open through both sides of the channel at spaced points. Along a portion of the length of the torch, the jet orifices on one side are located at different distances from the end of the channel than the jet orifices on the other side. Along another portion of the length of the torch, other jet orifices open so that their flame jets converge into resultant fishtail flames. The last flame jets are projected rearwardly and beyond the end of the torch. Transverse notches extend across the torch face and across the channel at regions between flame jet orifices.

» «

Butt Welder

2,302,420. **Verni J. Chapman**, Schenectady, N. Y., assigned to **General Electric Co.** Filed Dec. 13, 1941. Issued Nov. 17, 1942.

Butt welding apparatus of the type in which a pair of members are butt welded to form a continuous article. Elements include a means for supporting each of the members, a pair of pivoted levers for moving members out of engagement, a link joining the free ends of the levers, a roller journaled between the levers to guide the members during their insertion and withdrawal, and a fluid pressure means acting on the link for selectively moving roller into and out of engagement with the members.

» «

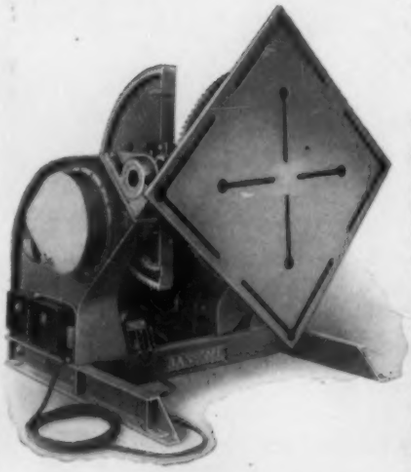
Welding Electrode

2,301,320. **Charles E. Phillips** and **Harry R. Pennington**, Detroit, assigned to **C. E. Phillips and Co.**, Detroit. Filed Feb. 12, 1940. Issued Nov. 10, 1942.

A welding electrode comprising a core of nickel and a surrounding coating of copper.

FOR ALL DOWNHAND WELDS

. . . a tilting range of 135 degrees from horizontal



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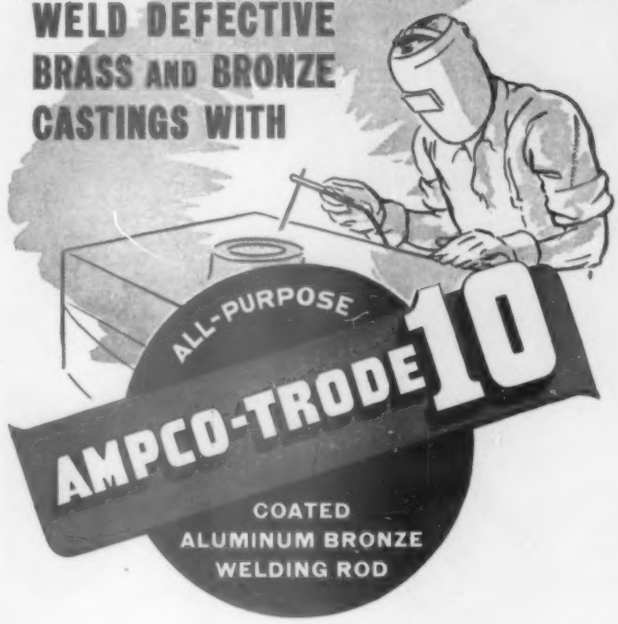

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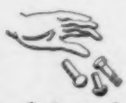

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Hard-Facing Fixture

2,301,763. **Robert L. Wagner**, Niagara Falls, N. Y., assigned to **Haynes Stellite Co.**, Kokomo, Ind. Filed Aug. 3, 1940. Issued Nov. 10, 1942.

Apparatus for applying annular welded-on overlays of protective metal upon a surface of an article of revolution. Included are: a support for the article to be hard-faced, a means for rotating the support upon a vertically disposed axis, a torch for directing welding flames upon a selected band or ring on the surface of the article thus supported, a means for feeding a body of protective metal to the surface, a means for preheating protective metal during the feeding operation, a means for concurrently reducing the flow of welding gases to the torch and for actuating the metal-feeding and metal-preheating means, and an automatic mechanism for rendering the metal-preheating means inoperative after a selected amount of protective metal has been fed.

» «

Flame-Conditioning Apparatus

2,301,909. **William A. Wissler** and **Robert L. Wagner**, Niagara Falls, N. Y., assigned to **Haynes Stellite Co.**, Kokomo, Ind. Filed Aug. 3, 1940. Issued Nov. 10, 1942.

A process and apparatus for conditioning the metal overlay portion of a metal article having the general shape of an article of revolution and having a surface provided with a continuous overlay of wear-resistant metal. Heating is first carried out along a progressively shifting portion of an annular zone at the surface of the overlay; this progressively melts and solidifies the overlay metal while maintaining the main body of metal below its softening temperature. The overlay is then heated progressively along the shifting zone, but not to melting temperature, and a slow regulated cooling is effected from the bottom toward the surface. The result is that any porous or soft metal present in the overlay metal is isolated within a thin layer at the surface.

» «

Spot Welding Apparatus

2,302,251. **Henry Thomas Platz**, Detroit, assigned to **Briggs Mfg. Co.**, Detroit. Filed Jan. 4, 1941. Issued Nov. 17, 1942.

This spot welding apparatus comprises a carriage for the work, a welding device having an electrode movable into and out of engagement with the work, an indexing mechanism for moving the carriage by a step-by-step movement, a means for engaging and releasing electrode during the intervals in which the carriage rests, a means for locking carriage while in its rest positions, and a means to release the carriage lock and operate the indexing mechanism.

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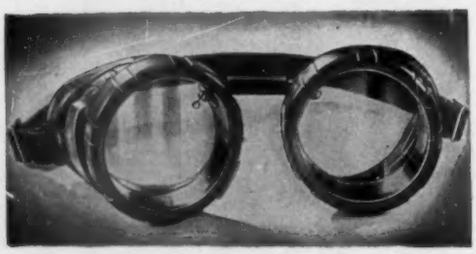

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AWS Meeting Papers in Digest Form

(Concluded from November issue)

Factors Affecting the Accuracy of Ordnance Machine Cutting

By HOWARD HUGHEY *and* A. H. YOCH
Air Reduction Sales Company

WITH THE mechanically operated cutting torch playing an important part in the fabrication of shapes from steel plate, demands for greater accuracy have become increasingly common. The degree of accuracy attainable is dependent upon many factors, but outstanding is that of relative motion of plate and torch while cutting.

Plate motion is created by the expansive and contractive forces which occur during the cutting and cooling. A study of this motion discloses that some of the common practices permit an erratic motion pattern and cause shifting of such magnitude as to seriously affect the accuracy. Where the motion can take place freely and the plate is not restricted, the magnitude of motion was cut in half and the pattern was uniform. The freedom of motion was gained by mounting the plate on its central section, preventing the scrap and cut from coming in contact with the support. The final examination disclosed that when the plates were mounted to give freedom of motion the inaccuracies were only 50% of those produced with plates mounted on rough and irregular surfaces.

Among other factors which also affect accuracy are: the design of the shape with respect to simplicity; the design of the machine, its workmanship, and capability; careful maintenance and proper use of the mechanical equipment, and such characteristics of the plate as chemical analysis, surface condition, and heat treatment. The chemical analysis will affect the specific setting of conditions for operation; the surface will affect the quality; internal stresses resulting from heat treatment prior to cutting may cause the plate to shift while being cut.

Sufficient analysis will develop a basis for predicting the most probable result. By applying control to the factors which affect accuracy, errors can be kept to a minimum and results equal in accuracy to those of any other metal working process can be and are being obtained.

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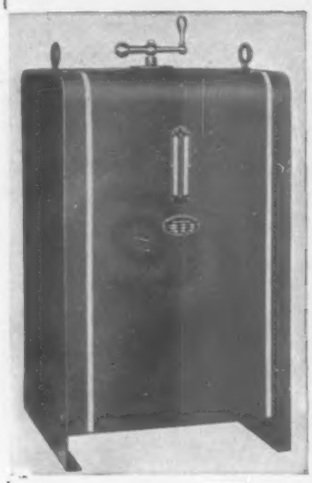

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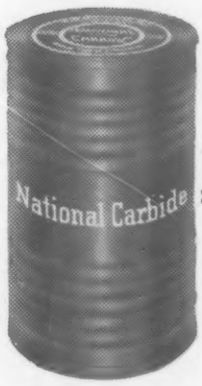

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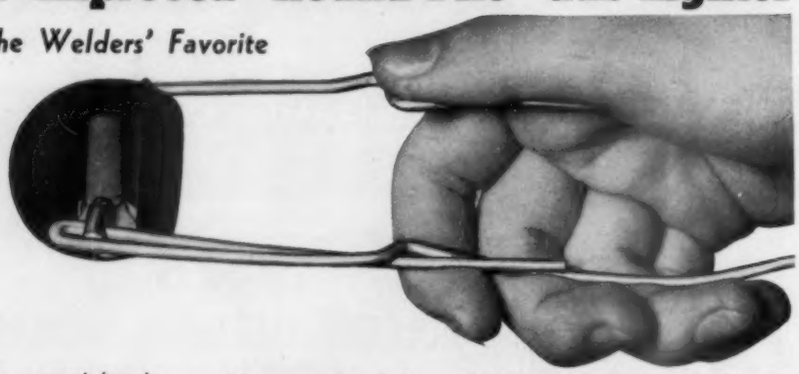

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Weldability of Carbon-Manganese Steels; Weld-Bead Hardness and Weld-Bead Bend Tests

By OSCAR E. HARDER *and* C. B. VOLDRICH
Battelle Memorial Institute

THIS PAPER presented the preliminary study of the weldability of carbon-manganese steels sponsored at Battelle Memorial Institute by Committee II, Industrial Research Division, Welding Research Committee of the Engineering Foundation.

Ten commercial wrought steels, three experimental wrought steels, and three cast steels were studied. The steels fall into Group I, 0.20 to 0.24 C, 0.35 to 0.40 Mn; Group II, 0.26 to 0.30 C, 0.60 to 0.70 Mn; Group III, 0.30 to 0.35 C, 0.90 to 1.10 Mn; and Group IV, 0.30 to 0.35 C, 1.50 to 1.70 Mn.

In the commercial wrought steels, ¼ in., ½ in., 1 in. and 2 in. plates were used; in the experimental steels, ½ in. and 1 in.; in the cast steels, ½ in., 1 in. and 2 in.

Weld bead deposits were made at original plate temperatures of 80 F and 10 F, and the resulting hardness in the heat-affected zone determined. Tables and graphs show the relation of plate thickness and original plate temperature to the maximum hardness in the heat-affected zone for different carbon and manganese contents.

It is generally recognized that the hardness produced in the heat-affected metal is due to the combined effects of carbon and manganese. The relation of maximum hardness in the heat-affected metal to the increase in hardness in heat-affected metal is a function of the carbon plus one-sixth of the manganese contents.

The weld-bead hardness specimens were examined for cracks in the heat-affected zone. The minimum hardness at which a crack was found was 372 Vickers and with only two exceptions the maximum hardness of the specimens in which cracks were found was above 400 Vickers. Higher hardnesses were found under ½ in. beads than under 3 in. beads.

Weld-bead bend tests were limited to tests on ½ in. plates except for one steel where tests were made on ¼, ½, 1 in. and 2 in. plates. Both 6 in. and ½ in. bead deposits were used. The results of the weld-bead bend tests were less consistent than those of the weld-bead hardness tests. A tendency of the specimens to fail by cracks starting in the weld metal was noted in a number of cases. On the other hand, some specimens withstood the bend tests although the weld-bead hardness tests had indicated that hardnesses of 400 Vickers or over had been developed in the heat-affected zone.

» «

Welding in Aircraft

By FRANCIS H. STEVENSON
Vega Aircraft Corp.

THE WELDING procedure must be developed with great care. The size of the electrode, the size of the tip and the current setting of the arc machine are factors of prime importance.

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SPATTER-OFF — A companion water soluble product. Used where welds are to be pickled for galvanizing, sherardizing or plating. Spatter-Off is non-fuming. Covers 500 sq. ft. per gallon. Low priced—$1.00 per gallon.

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The welding technique must also be considered for the stopping and starting points as well as the direction of welding.

Both in oxy-acetylene and arc welding, hydrogen can be used to very good advantage for pre-heating, post-heating, elimination of scale, and in helping to control expansion and contraction of very thin sections.

The following are a few points that should be avoided when designing for fusion welding:

1. A joint between thin and heavy material. The heat required to bring the heavier metal up to the welding temperature may burn or melt away the thin metal. The end of the lug is thin as against the heavy tube; and the weldor will find it almost impossible to avoid melting the end of the lug.

2. Placing parallel weld beads close together. Either overlap the beads or keep a minimum of ¼ in. between nearest edges of beads.

The design of jigs for the fusion welding of aircraft parts is not a mere matter of a few C clamps and pieces of angle iron. It involves thorough consideration of the following points:

1. Proper allowance for shrinkage. Torch welded parts shrink more than arc welded parts. Stainless steel and aluminum have greater thermal expansion and contraction than low carbon steel.

2. Proper positioning. The work must be held in a position to make a good weld. Downhand positioning is preferred.

3. Accessibility and visibility. The weldor must not only be able to get at the work with the welding electrode or torch but must also be able to see clearly if he is to turn out high quality production.

4. Clamping devices. Screw clamps should be eliminated wherever possible, and quick-acting clamps used in their place.

The weldors must be certified to work on Army aircraft. This is carried out under Army Specification number 20013-B. For the carbon steel group there are four tests to be made. These are the plate, the tubes, the cross and the cluster.

A class "A" weldor, after passing all four tests, can be assigned to any weld assembly on the airplane.

The class "B" weldor can weld all but primary and secondary structures.

Welding of Aircraft Propellor Blades

By C. A. LIEDHOLM
Curtiss-Wright Corporation

SOLID PROPELLER blades are built from wood and aluminum, hollow blades from steel. In spite of higher cost and more complicated manufacture, hollow steel blades have defended their position for the following reasons:

1. Lighter weight because of the superior static mechanical properties and endurance strength of steel.
2. Greater hardness and abrasion resistance.

The Curtiss hollow steel blade is the only one on the market assembled entirely by welding.

The component parts are the camber or curved plate, which is rolled up in one end to form the shank, and the thrust or flat plate. Both plates are milled, blanked, formed and then assembled in the welding jig.

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The welding technique must also be considered for the stopping and starting points as well as the direction of welding.

Both in oxy-acetylene and arc welding, hydrogen can be used to very good advantage for pre-heating, post-heating, elimination of scale, and in helping to control expansion and contraction of very thin sections.

The following are a few points that should be avoided when designing for fusion welding:

1. A joint between thin and heavy material. The heat required to bring the heavier metal up to the welding temperature may burn or melt away the thin metal. The end of the lug is thin as against the heavy tube; and the weldor will find it almost impossible to avoid melting the end of the lug.

2. Placing parallel weld beads close together. Either overlap the beads or keep a minimum of ¼ in. between nearest edges of beads.

The design of jigs for the fusion welding of aircraft parts is not a mere matter of a few C clamps and pieces of angle iron. It involves thorough consideration of the following points:

1. Proper allowance for shrinkage. Torch welded parts shrink more than arc welded parts. Stainless steel and aluminum have greater thermal expansion and contraction than low carbon steel.

2. Proper positioning. The work must be held in a position to make a good weld. Downhand positioning is preferred.

3. Accessibility and visibility. The weldor must not only be able to get at the work with the welding electrode or torch but must also be able to see clearly if he is to turn out high quality production.

4. Clamping devices. Screw clamps should be eliminated wherever possible, and quick-acting clamps used in their place.

The weldors must be certified to work on Army aircraft. This is carried out under Army Specification number 20013-B. For the carbon steel group there are four tests to be made. These are the plate, the tubes, the cross and the cluster.

A class "A" weldor, after passing all four tests, can be assigned to any weld assembly on the airplane.

The class "B" weldor can weld all but primary and secondary structures.

Welding of Aircraft Propellor Blades

By C. A. Liedholm
Curtiss-Wright Corporation

Solid propeller blades are built from wood and aluminum, hollow blades from steel. In spite of higher cost and more complicated manufacture, hollow steel blades have defended their position for the following reasons:

1. Lighter weight because of the superior static mechanical properties and endurance strength of steel.
2. Greater hardness and abrasion resistance.

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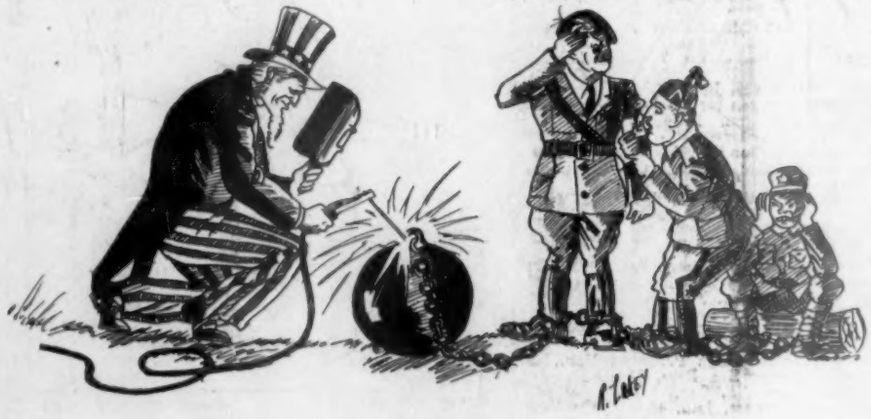

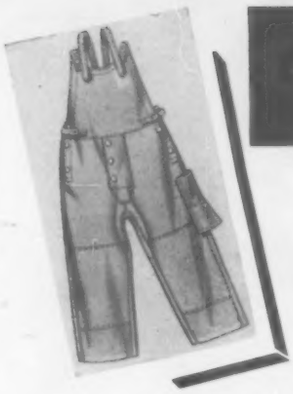

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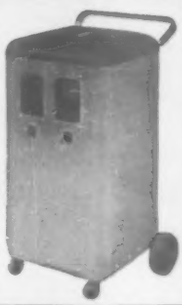

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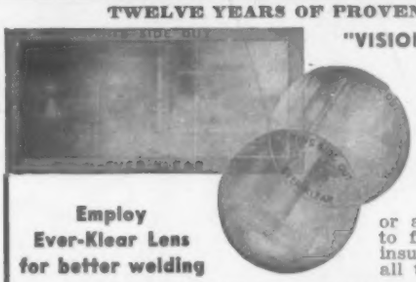

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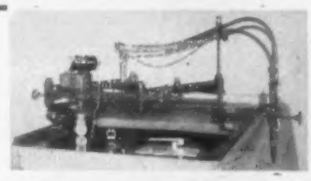

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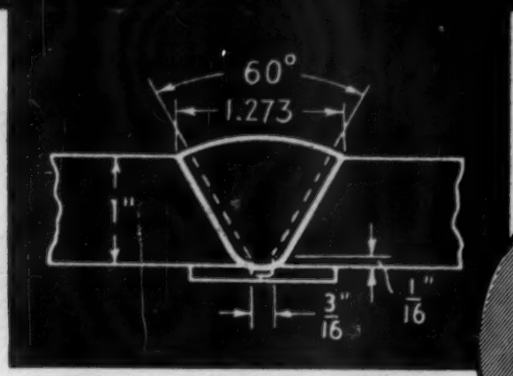

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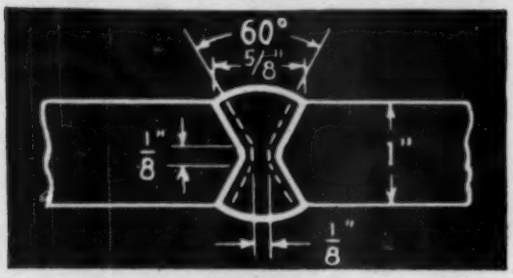
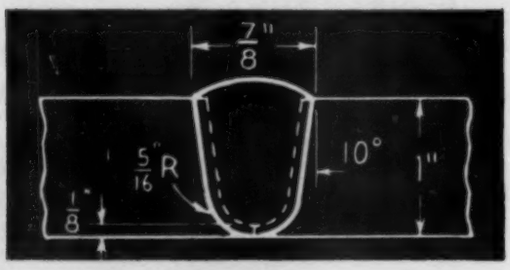
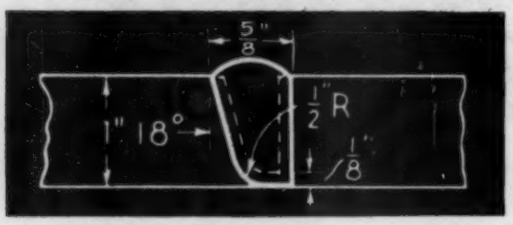


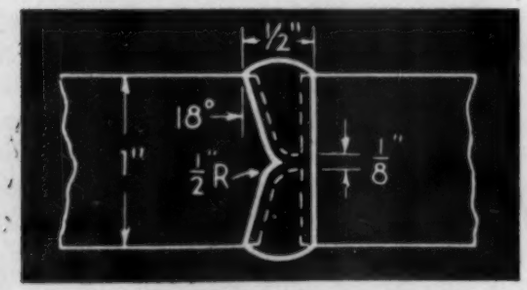
2. Partially grooved 60° Double-V Butt Joint
Averages 3.02 lbs. electrodes per linear foot.



3. Single-U Butt Joint
Averages 3.85 lbs. electrodes per linear foot.



4. Single-J Butt Joint
Averages 2.70 lbs. electrodes per linear foot.



5. Double-J Butt Joint
Averages 2.20 lbs. electrodes per linear foot.

SELECTION OF PROPER JOINT HELPS CONSERVE ELECTRODES

WITH the critical shortage in electrodes, it is of vital importance that careful thought be given to employing joint designs that require minimum amounts of weld metal, bearing in mind, of course, the requirements of the job and all of the many variable factors, such as joint preparation, cleaning time, and welding procedure.

Other things being equal, it may be possible to save a substantial quantity of electrodes by substituting one joint for another, without sacrificing necessary strength or adding to labor costs.

For instance, in butt welding one inch plate, original specifications might call for a partially grooved 60° Single-V Butt Joint (Fig. 1), requiring an average of 4.56 pounds of electrodes per foot of weld. Under certain circumstances, a Double-V Butt Joint (Fig. 2) would be just as practical and this joint would require only 3.02 pounds per foot, making a saving of more than 33% in pounds of electrodes consumed.

A study of the accompanying sketches shows other comparisons of the amounts of electrodes needed for various types of joints on butt welds.

We have prepared a complete set of charts showing the pounds of Murex electrodes required per linear foot of weld in common types of joints. Copies will be sent on request.

METAL & THERMIT CORPORATION

120 BROADWAY, NEW YORK, N. Y.

Specialists in welding for nearly 40 years. Manufacturers of Murex Electrodes for arc welding and of Thermit for repair and fabrication of heavy parts.

* Note: All of the above are for welding one inch plate. Figures are based on average conditions and are given only to illustrate the principle involved.

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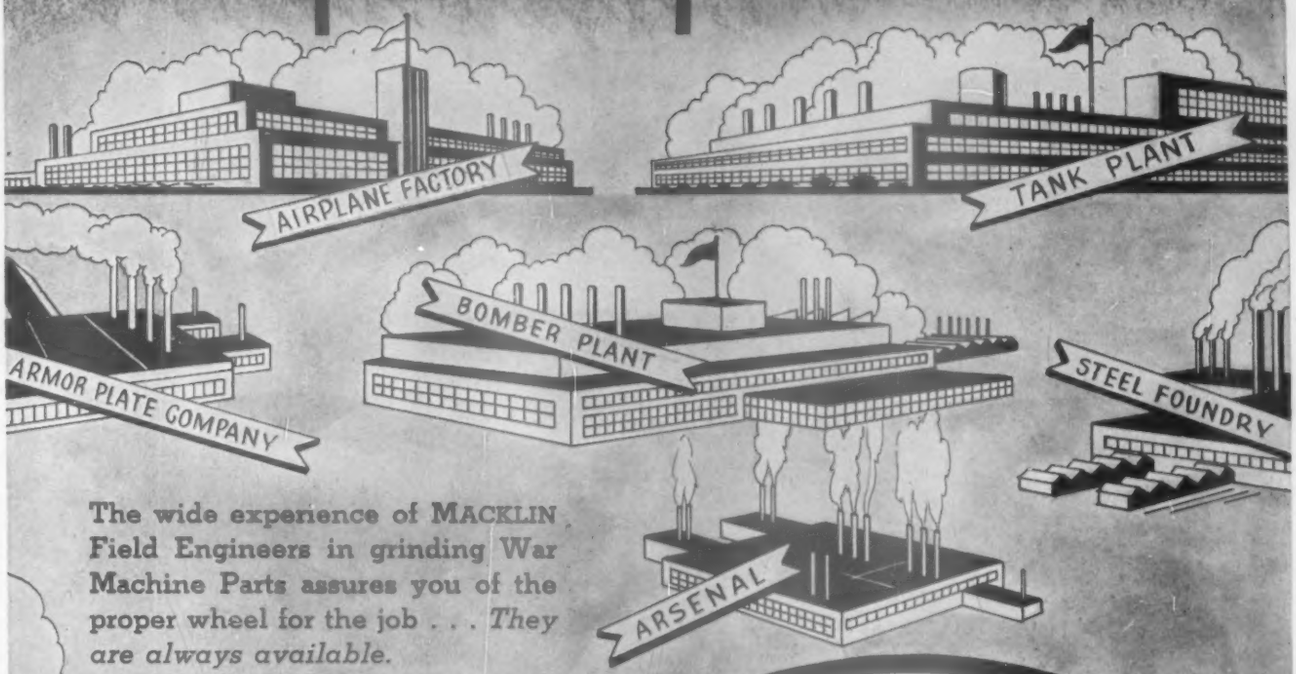
ARC WELDING ELECTRODES

MACKLIN
Grinding Wheels



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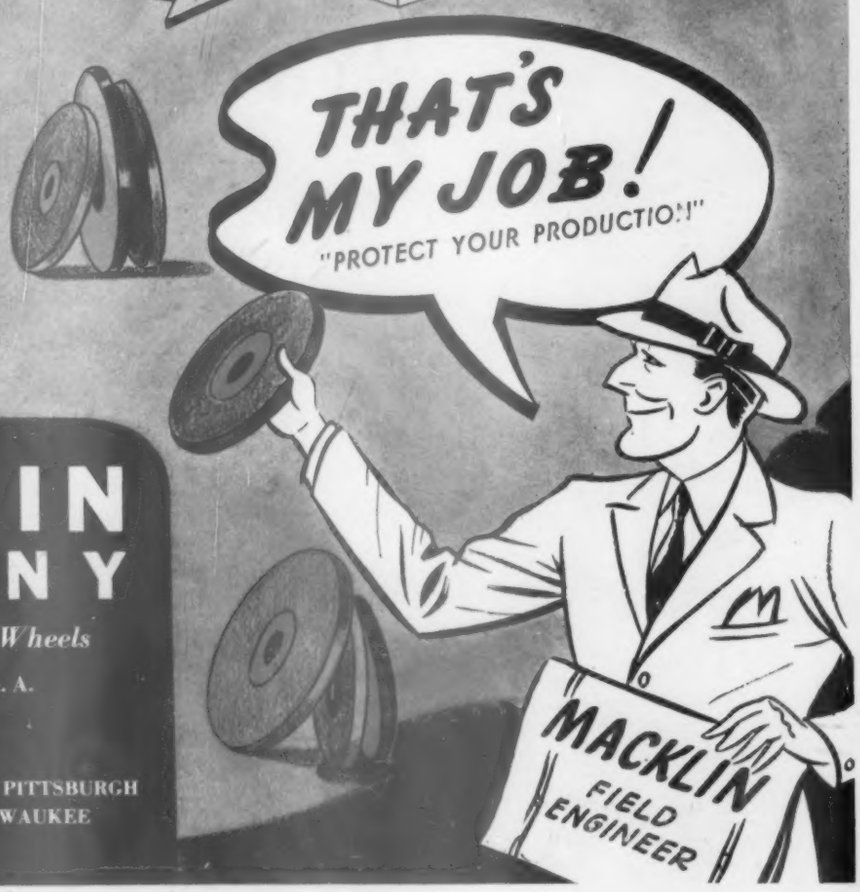

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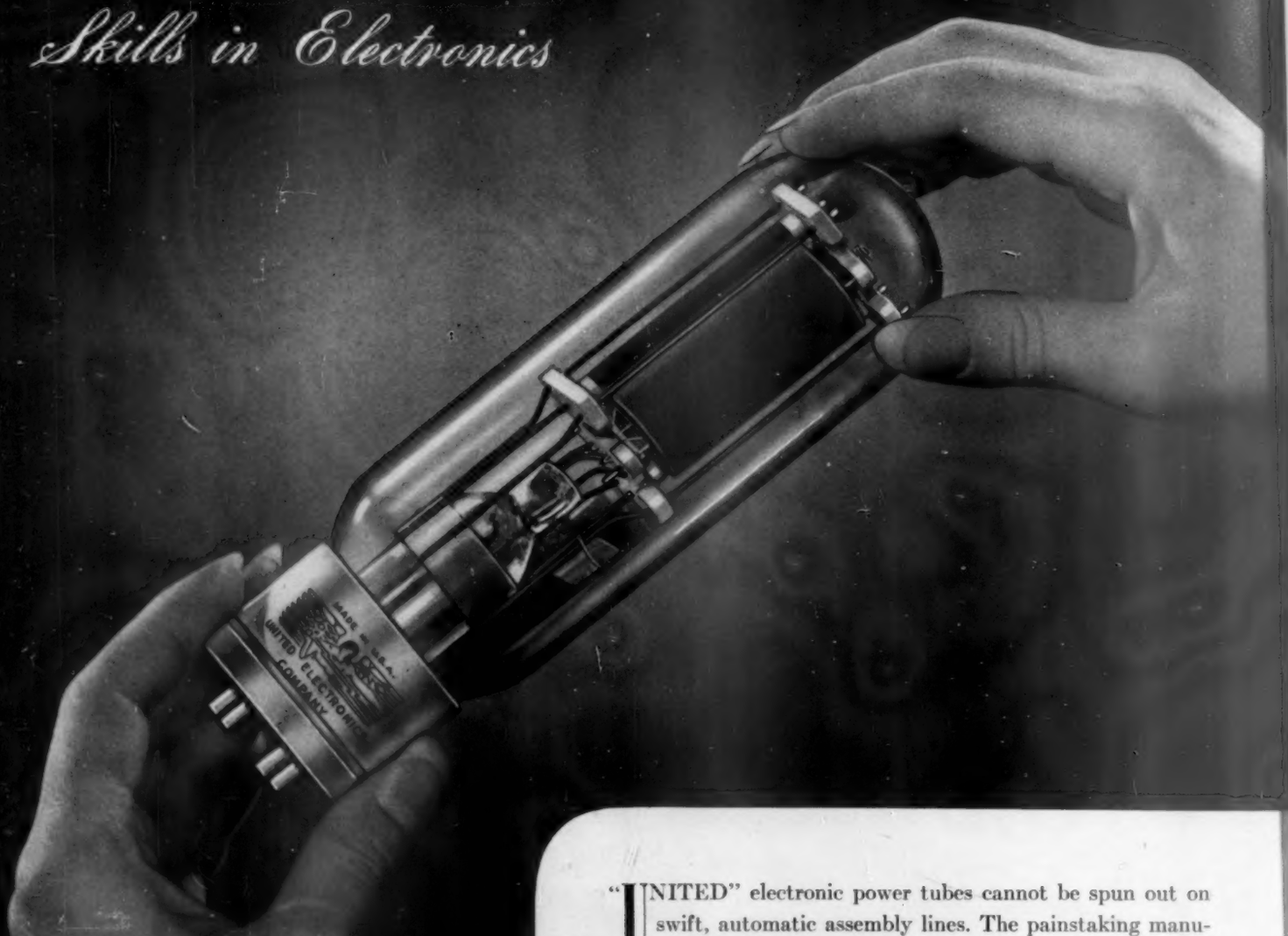


"UNITED" electronic power tubes cannot be spun out on swift, automatic assembly lines. The painstaking manufacturing of these sensitive devices requires the skill of human hands.

Here at the "United" Plant, incredibly accurate hands perform under a system of personal supervision by electronic engineers. One by one, the steps of forming and fitting the stems, leads, plates, grids, wires and rods combine to produce tubes of such flawless precision that they consistently win top rating of performance. Never before were the hands of craftsmen and the brains of scientists so superbly "United" in advancing the scope and purpose of electronics.

Consistent technical advances in electronic power tubes, now required for war communications, are available to you for the exacting demands of resistance welding. Remember to look for "United" on the tubes.

UNITED ELECTRONICS COMPANY

NEWARK, NEW JERSEY

Here's How to
WELD IN LASTING LININGS
to stand the pace of wartime speed-up!

Stepping up the service life of process tanks and vessels—old or new—is vital in today's war production, you'll agree.

This may often be readily done by welding linings of sturdy, corrosion-resisting metals or alloys into new or old vessels of steel, wood or concrete.

Monel*, Nickel* and Inconel* in sheet form are formed easily to all types of vessel contours. Sheets are punched for plug welding, and are also readily welded to themselves or to the steel vessel by the electric arc process.

In fact, electric arc welding is the only process recommended for the attachment of separate linings to steel equipment.

The recommended sheet thickness for welded-in linings using Monel, Nickel or Inconel set by practical fabricating considerations is .062 in. (16 ga. U.S.S.) or heavier. Usually, all welds are left in the as-welded or reinforced condition.

In lining existing equipment, sheets are employed as large as can be handled conveniently, or, if the vessel be closed, that can be put through a manhole or other opening.

In storage tanks 7 ft. or 8 ft. in diameter and smaller, in which fluctuations in pressure (breathing) are not to be encountered, the long dimension of each sheet may be disposed either longitudinally or circumferentially. Attachment to the steel by intermittent welds at sheet edges is sufficient, but lapped welds in the lining sheets obviously should be continuous. Because of the mild mechanical requirements of service, plug welds are not necessary.

*Subject to Government priority regulations.

Lining with narrow strips may be used in special cases where large sheets are impractical. Plug welding is omitted because strips are relatively small, from 3 in. to 12 in. wide and up to 4 ft. in length. Again .062 in. sheet or heavier is recommended.

Linings in Wood Tanks. In lining wood tanks with sheet metal, joints can be made either by soft soldering or silver brazing in the case of lighter gauges, .050 to .037 in. or thinner, or by electric arc welding in .050 or .062 in. sheet. For arc welding, a butt strap, to prevent burning of the wood and to anchor the lining of the tank, is placed behind each seam and it usually is screwed to the wood. If necessary, the lining itself can be screwed to the wood with Monel screws on 8, 12 or 24 in. centers according to requirements. The heads of the screws should be covered with soft solder or preferably silver brazing alloy to insure liquid tightness.

Linings in Concrete Tanks. Tanks are prepared to receive a lining by attaching ¼ in. x 1 in. steel flats to the concrete by regularly available anchors or foundation bolts.

For further information write for Bulletin T-2 "Welding, Brazing and Soft Soldering of Monel, Nickel and Inconel." Address:

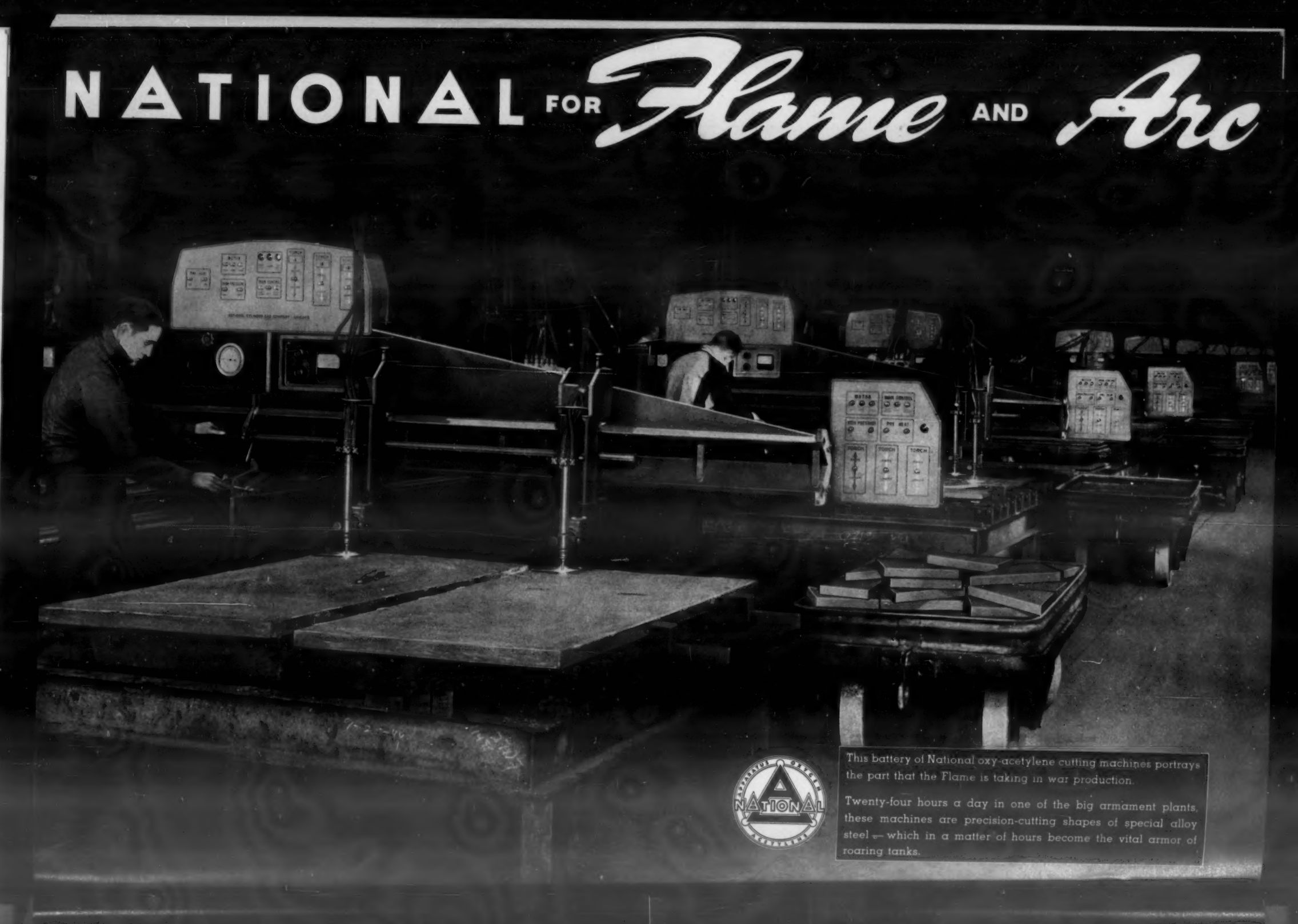
THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street **New York, N.Y.**

★ ★ ★ ★ ★ **INCO NICKEL ALLOYS** ★ ★ ★ ★ ★

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • "Z" NICKEL • NICKEL

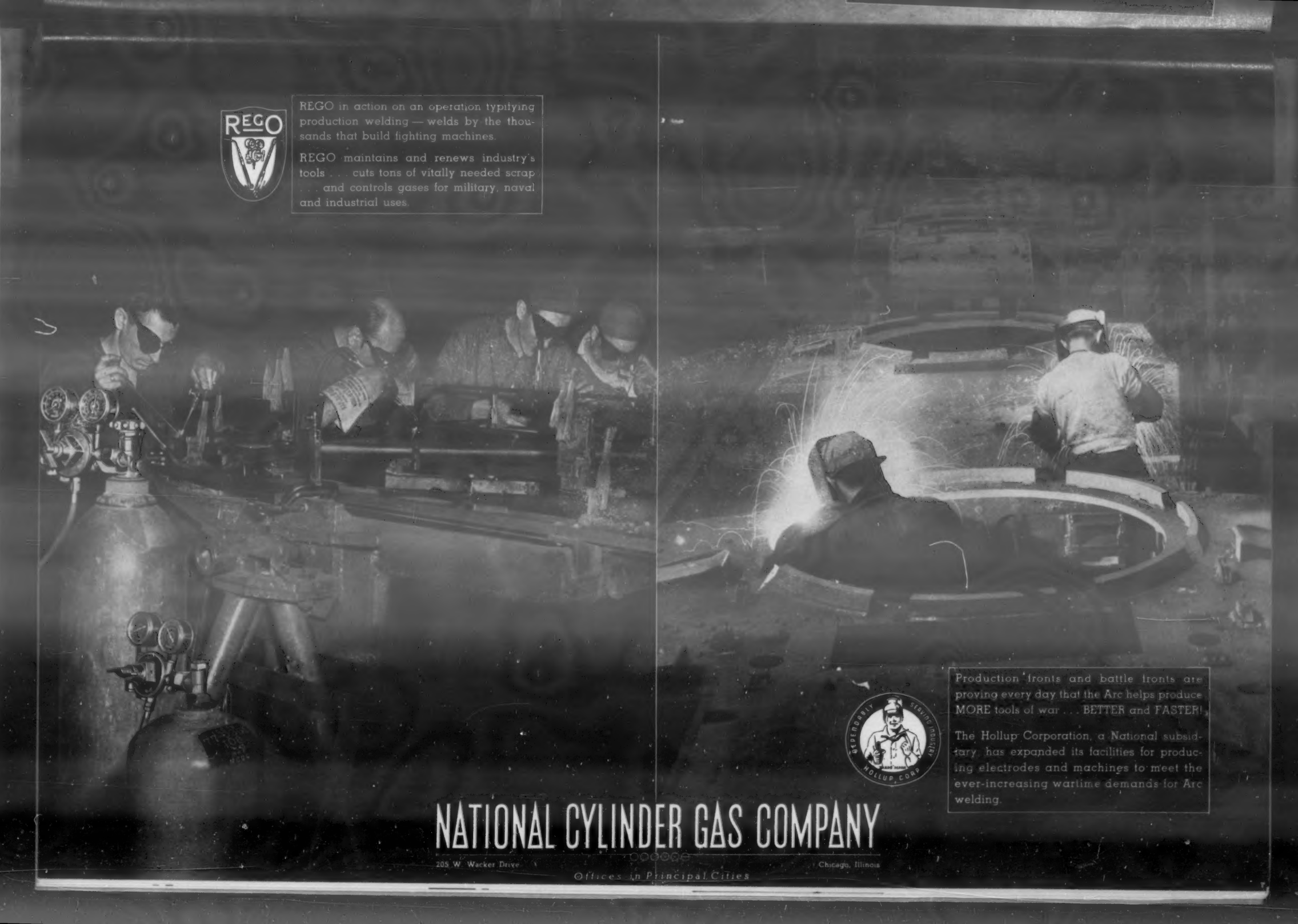
Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings

NATIONAL FOR *Flame* AND *Arc*



This battery of National oxy-acetylene cutting machines portrays the part that the Flame is taking in war production.

Twenty-four hours a day in one of the big armament plants, these machines are precision-cutting shapes of special alloy steel — which in a matter of hours become the vital armor of roaring tanks.


REGO
REGO in action on an operation typifying production welding — welds by the thousands that build fighting machines.
REGO maintains and renews industry's tools . . . cuts tons of vitally needed scrap . . . and controls gases for military, naval and industrial uses.
Production fronts and battle fronts are proving every day that the Arc helps produce MORE tools of war . . . BETTER and FASTER!
The Hollup Corporation, a National subsidiary, has expanded its facilities for producing electrodes and machines to meet the ever-increasing wartime demands for Arc welding.
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Available without Priority

FOR MAINTENANCE AND REPAIRS

Rebuild worn parts — conserve precious steels, save time, save money — and aid the war effort by welding.

For hard surfacing, resistance to wear, abrasion, and impact, P&H Alloy Electrodes may be obtained without priority. The only restriction is that the electrodes be used for maintenance and repair work.

P&H is ready to help you: First, in making available a full line of alloy electrodes for hard surfacing, welding of stainless steels, 4-6% chrome steels, etc. Second, by answering your specific questions as to the proper choice and applications of electrodes to solve your maintenance and repair problems.

See your nearest P&H welding representative or write us for the list of P&H Alloy Electrodes along with recommended modern welding procedures.

P&H-HANSEN WELDERS

Square frame design permits stacking of machines for single or multiple use with instant parallel hook-up. In either case single control provides any desired welding current with automatic arc response on all classes of work. Simpler, more accurate, easier to learn. Write for Bulletin W-28 for complete information.

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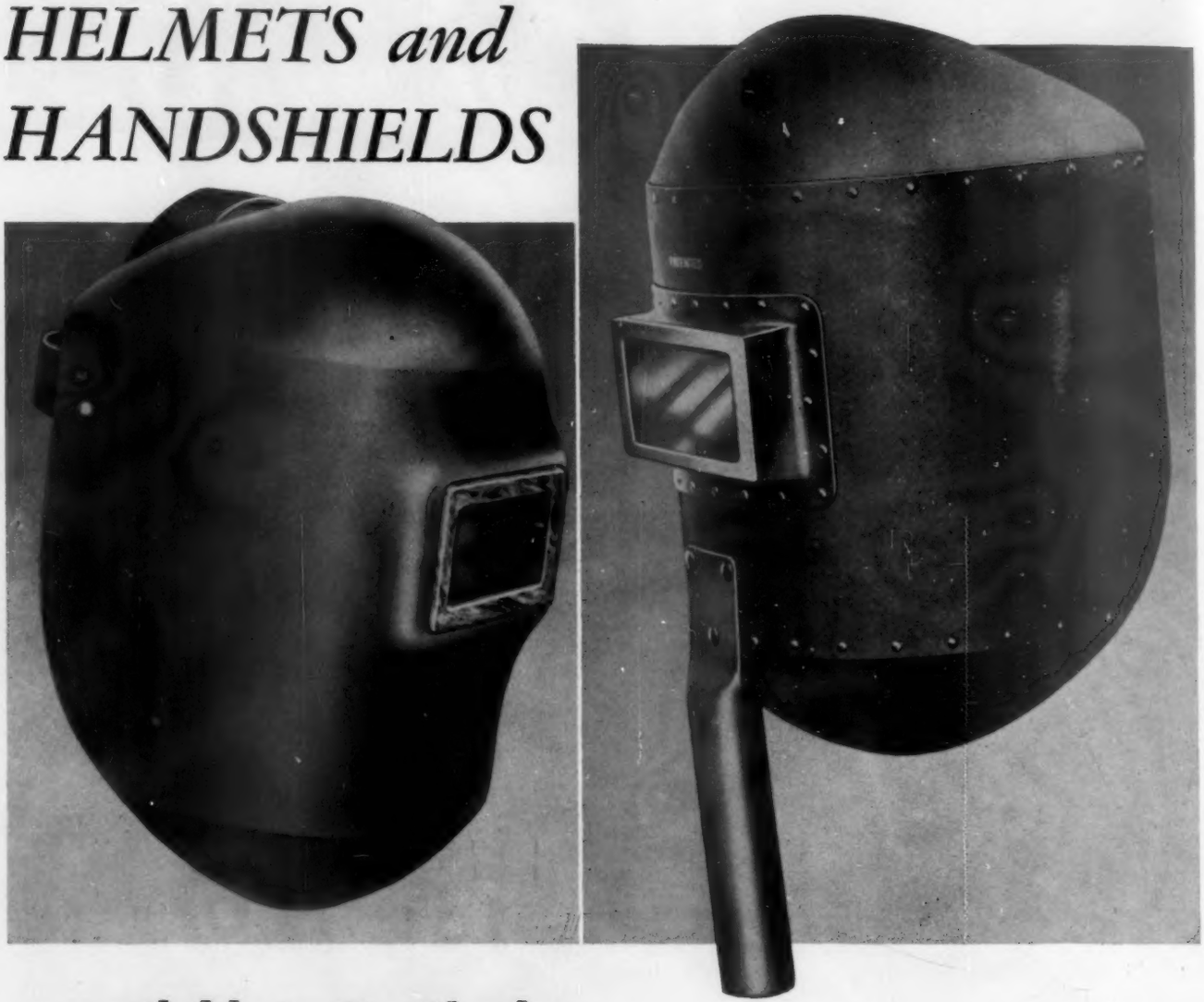
Filterweld* Welding Plates

developed by AO Research for your HELMETS and HANDSHIELDS



...available in Six Shades

AO Filterweld* Welding Glass, scientifically controlled in production, with fixed standards of densities to conform with U. S. Bureau of Standards Specifications, is now available, *without waiting,* for your helmets and handshields. Filterweld* is a service-proved welding glass that absorbs 100% of the ultra-violet rays and more than 99% of the dangerous infra-red rays. It can be obtained in six shades—Nos. 8, 9, 10, 11, 12, and 13. For your Filterweld* Welding Plates, get in touch with your nearest American Optical Branch Office.

*T. M. Reg. U. S. Pat. Off.

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COMPANY
SOUTHBRIDGE, MASSACHUSETTS

What's Here?

★ **HEALTH** Is there a health hazard from working in arc welding fumes? Many newcomers to the welding industry have been disturbed by rumors that welding fumes create a dangerous working atmosphere. Medical science, however, is able to allay these fears. See page 27.

★ **RESEARCH** Further details pertaining to the inert gas process for arc welding magnesium alloys are given in this issue, beginning on page 30.

★ **PRODUCTION** Because castings of any size can be welded quickly with thermit, the thermit welding process is now being employed in many shipyards for joining cast stern-frame sections into complete assemblies. See page 36.

★ **SPOT WELDING** Part two of the article, "The Spot Welding of N-A-X High Tensile Steel," discusses the results obtained with material of 0.070 in. thickness. Page 40.

★ **CONSTRUCTION** Accurate information on the costs, power requirements, welding time, etc., involved in welded building construction will be found in the important article beginning on page 43.

★ **MAINTENANCE** Due to priority restrictions, many plants are unable to replace their wire cloth filter screens. This article tells how to repair non-ferrous screens with silver-brazing using a gas flame. Page 49.

What's Coming?

Welding Gains for 1942. This review of a year's progress by the editor of THE WELDING ENGINEER will summarize new uses, developments and equipment and highlight the outstanding accomplishments in each of the principle branches of the welding industry—arc, gas, resistance and thermit welding.

The Hardening Flame. A non-technical discussion of flame-hardening principles and technique will begin next month. This will be a series of three articles designed to refresh the memories of those already acquainted with the subject as well as serving as a useful guide for the newcomer in this field.

Magnesium Welding. Part Two of the article, "Arc Welding Magnesium Alloys," will show how the helium arc process can be applied to production methods.

HARRIS

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"HARRIS" HAND TORCHES FOR THESE GASES ARE ALSO USED IN THOUSANDS OF LARGE PLANTS

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Still Going Strong

AFTER 6 MONTHS OF CONTINUOUS WELDING— Without a cent Spent for Replacement or Repair!

Unretouched photograph of fully-insulated Wells "Suregrip" Holder, after 6 months continuous service without repair or replacement of any parts.

You, too can get long low-cost Service from . . .

Wells "Suregrip" Holders

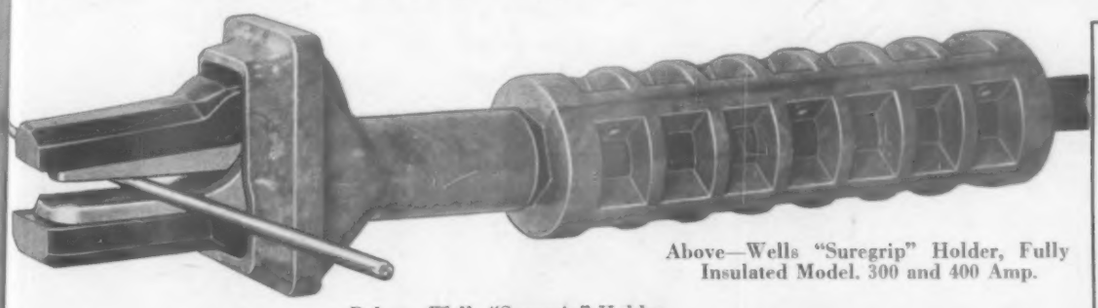
This fully-insulated Wells Holder looks badly battered after 6 months of hard, continuous use. Actually, all it needs to make it fit for months of additional service is a new set of jaw insulators, costing but a few cents. Replacing the jaw insulators is done on the job in a minute, without tools. The old insulators are broken off with the chipping hammer, and the new insulators are slipped into position on the jaws, where they are held permanently by a molded-in, fully covered snap. It's as easy as that—no screws, no chance of the insulators loosening or coming off.

Even when neglected—as this "Suregrip" has been—Wells Holders give more than your money's worth of service.

With Wells Holders a little attention pays big dividends in the form of greatly lengthened service life. In the case of this holder, had the operator replaced the jaw insulators after three or four months, the tool would now be practically as good as new. The ease and low cost of maintenance is one reason why "Suregrip" Holders have been the standard of comparison for 16 years.

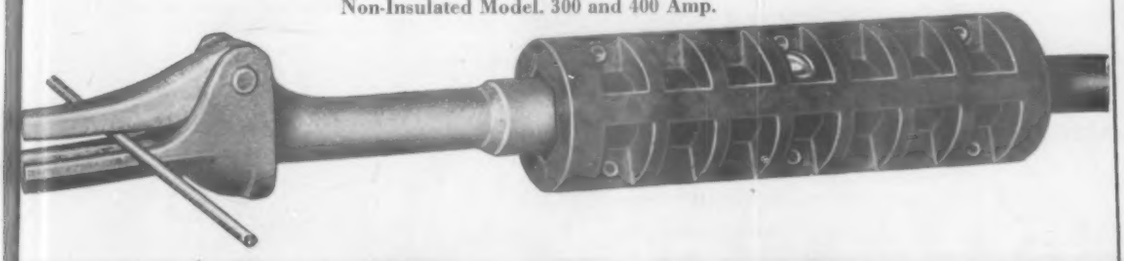
Wells Holders have other good points. They are light, and balanced to prevent fatigue of the weldor's fingers and forearm. The handle is thoroughly ventilated and STAYS COOL. The electrode is held in a positive, vise-grip in any desired position, and electrodes are changed in an instant with a twist of the wrist.

Try Wells "Suregrip" Holders on your job. Your weldors will like them and you will benefit from getting longer holder service with less upkeep cost. Contact a "Suregrip" distributor, your dealer, or write to the manufacturer for full information and prices.



Above—Wells "Suregrip" Holder, Fully Insulated Model. 300 and 400 Amp.

Below—Wells "Suregrip" Holder, Non-Insulated Model. 300 and 400 Amp.



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MALLORY STANDARDIZED WELDING ELECTRODES

SPEEDIER PRODUCTION

BETTER WELDING

LESS DOWN TIME

LOWER COST

Spot welding a bomb bay section with Mallory tips. Courtesy—Douglas Aircraft Company, Inc.

Mallory Electrodes Speed Bomber Production!

At the huge plants of Douglas Aircraft Company, Inc., attack bombers and night fighters are built rapidly and efficiently. Here, as at many other aircraft factories in the United States and Great Britain, Mallory Resistance Welding Electrodes speed the wings of war into the air!

According to production men at Douglas Aircraft, "resistance welding has speeded up production by consolidating several operations, formerly necessary in the production of planes, with one quick efficient operation. It is expected that resistance welding will play an even more important part in aircraft production . . . "

Yes, sir. Because new resistance welding machines are being designed by American engineers . . . new machines that will do far more than those built even a few years ago. Mallory spot welding tips, seam welding wheels and dies for flash, butt or projection welding are keeping pace with these new welders.

Mallory Resistance Welding Electrodes have won top place among welding engineers in every industry, in war as well as peace, because these electrodes are made of specially developed Mallory alloys—and are designed for high-speed production with minimum down time and more welds per electrode.

Write to Mallory welding engineers for answers to your specific problems on resistance welding. Perhaps you'd also like a free copy of the MALLORY RESISTANCE WELDING DATA BOOK. It's used by engineers and research men in the aircraft, automotive, electrical, steel, copper, aluminum and many other industries. Write us for your copy today!

P. R. MALLORY & CO., Inc., INDIANAPOLIS, INDIANA • *Cable Address*—PELMALLO

RESISTANCE WELDING — P. R. MALLORY & CO. Inc. MALLORY — STANDARDIZED ELECTRODES

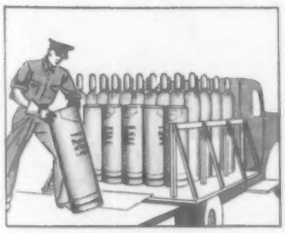
Proper Care of Oxygen and Acetylene Cylinders and Prompt Return of Empties.. *are Vitally Important to War Production*

Cylinders are a main supply line for many vital applications of the oxy-acetylene process in war production. Only as much "cylinder" oxygen and acetylene can be supplied as there are cylinders available in which to transport it. For this reason, it is extremely important to make every effort to keep cylinders doing a maximum amount of work. Some of the ways in which you can help to do this are outlined here.

• • •

Send for Reprints or Posters

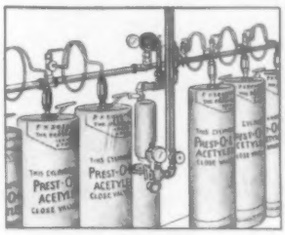
You can obtain as many copies of this page as you require, for distribution in your shops, upon request from any Linde Office. Also available is an assortment of colored posters suitable for posting on bulletin boards to remind your employees of the necessity for cylinder conservation.



1. Don't overstock. Anticipate your requirements and order minimum amounts. The Linde Air Products Company and other suppliers are making every effort to make deliveries of gases as needed and thus to avoid tying up cylinders needlessly.

2. Use partly full cylinders whenever possible before using full cylinders. Take partly full cylinders out on the job, even though it involves some inconvenience. This will permit faster return of empties because less cylinders will be tied up in your shop.

3. Return empties promptly so that they can be refilled with the least loss of time.



4. Centralize your work requiring use of oxygen and acetylene wherever possible. This will eliminate "low - consumption" points where cylinders may stand idle for days at a time, and will permit fewer cylinders to do the same amount of work.

5. Keep oil and grease away from oxygen cylinders. Oil and grease may ignite violently in the presence of oxygen under pressure. For this reason, cylinders that are contaminated must be cleaned before refilling, adding as much as two days to the time they are out of service.

6. Protect cylinders and valves from damage. Always replace the cap when the cylinder is not being used. Avoid careless handling, dropping, or other abuse—such as using the cylinder as a roller or support.

7. Avoid arc burns on cylinders. Do not knock electrodes or electrode holders against cylinders, or against any metal object which is in contact with the cylinder. *One arc burn, inflected in only a split second, may mean withdrawal from active service of the cylinder.*

The Linde Air Products Company
Unit of Union Carbide and Carbon Corporation
30 East 42nd St. UCC New York, N. Y.
Offices in Principal Cities
In Canada: Dominion Oxygen Company, Limited, Toronto

The words "Linde" and "Prest-O-Lite" are trade-marks.

Proper Welding Accessories and Increase Production

Select yours from this new G-E catalog — — — describes and illustrates more than 100 items

THIS new 32-page G-E catalog is more than a mere listing of products—it is a complete, up-to-the-minute reference book on all important arc-welding accessory items. Profusely illustrated throughout, it contains a wealth of important information.

Designed for quick, easy reference, this catalog contains complete, detailed descriptions of every standard accessory used by arc-welding operators. Full buying specifications, prices, and four sets of convenient order blanks are also included.

Proper arc-welding accessories do more than assure safe, comfortable operation—they help speed up production by providing better working conditions and reducing the time lost in making adjustments of equipment.

For this reason, every operator, every supervisor and foreman, should study this new G-E catalog carefully. For your copy, simply ask your G-E arc-welding distributor or local G-E office for GEA-2704B, or use coupon on opposite page.

ARC-WELDING ACCESSORIES FOR WOMEN is the title of another new G-E catalog which describes and illustrates a complete line of helmets and handshields, electrode holders, and protective clothing particularly suited for women. For your copy, contact your G-E arc-welding distributor or local G-E office and ask for GEA-3295, or use coupon on opposite page.

Promote Safety

HELMETS AND HANDSHIELDS—
many different types, including the popular G-E ventilated head protectors.

WELDING LENSES AND COVER GLASS—
four standard shades of welding lenses and both treated and untreated cover glass.

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specially designed to protect the eyes against flying slag particles and flashes from other arcs while the helmet is raised.

PROTECTIVE CLOTHING—
made of five-ounce chrome leather for comfort and safety. Aprons, pants, jackets, coats, overall, sleeves, gloves and mittens.

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eight selected types of metal electrode holders to meet every need; three types of carbon electrode holders.

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a number of different styles, including the widely used G-E combination slag chipper with steel brush.

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an easily-applied liquid that prevents the adhesion of weld spatter.

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cable connectors, welding clamps, electrode carriers, arc-welding cable, weld gage, ultra-violet-ray protective paint, etc.

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GENERAL ELECTRIC

The eyes of all America are upon the United States Treasury Roll of Honor appearing in the "Payroll Savings News." For copy write War Savings Staff, Treasury Department, Washington, D. C.

HOW TO "TOP THAT 10% BY NEW YEAR'S"

Out of the 13 labor-management conferences sponsored by the National Committee for Payroll Savings and conducted by the Treasury Department throughout the Nation has come this formula for reaching the 10% of gross payroll War Bond objective:

1. ***Decide to get 10%.***
   It has been the Treasury experience wherever management and labor have gotten together and decided the job could be done, the job was done.
2. ***Get a committee of labor and management to work out details for solicitation.***
   a. They, in turn, will appoint captain-leaders or chairmen who will be responsible for actual solicitation of no more than 10 workers.
   b. A card should be prepared for each and every worker with his name on it.
   c. An estimate should be made of the possible amount each worker can set aside so that an "over-all" of 10% is achieved. Some may not be able to set aside 10%, others can save more.
3. ***Set aside a date to start the drive.***
4. ***There should be little or no time between the announcement of the drive and the drive itself.***
   The drive should last not over 1 week.
5. The opening of the drive may be through a talk, a rally, or just a plain announcement in each department.
6. Schedule competition between departments; show progress charts daily.
7. Set as a goal the Treasury flag with a "T."

As of today, more than 20,000 firms of all sizes have reached the "Honor Roll" goal of at least 10% of the gross payroll in War Bonds. This is a glorious testimony to the voluntary American way of facing emergencies.

But there is still more to be done. By January 1st, 1943, the Treasury hopes to raise participation from the present total of around 20,000,000 employees investing an average of 8% of earnings to over 30,000,000 investing an average of at least 10% of earnings in War Bonds.

You are urged to set your own sights accordingly and to do all in your power to start the new year on the Roll of Honor, to give War Bonds for bonuses, and to purchase up to the limit, both personally and as a company, of Series F and G Bonds. (Remember that the new limitation of purchases of F and G Bonds in any one calendar year has been increased from $50,000 to $100,000.)

TIME IS SHORT. Our country is counting on you to—

"TOP THAT 10% BY NEW YEAR'S"

Save with
War Savings Bonds

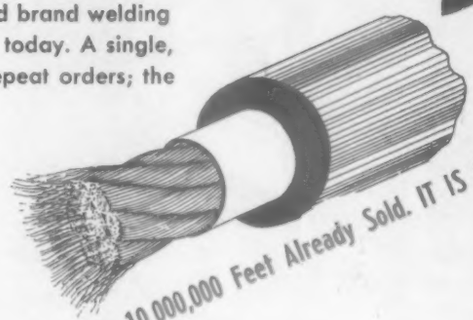
This space is a Contribution to America's All-Out War Effort by THE WELDING ENGINEER

"MAJOR" RUBBER COVERED SUPER FLEXIBLE WELDING CABLE

First IN ALL WARTIME INDUSTRIES

Super-flexibility and long life make "MAJOR" the preferred brand welding cable in shipyards, arms plants and all wartime industries today. A single, independent shipyard has bought 167,000 feet in *four* repeat orders; the U. S. Navy 300,000 feet and the British 100,000. These are typical orders.

Today "MAJOR" is the fastest selling welding cable on the market. It sells so fast because it's tough, durable and extremely flexible—because it combines low cost with highest quality and dependability. To get the best specify "MAJOR." The evidence supports its superiority.



Nearly 10,000,000 Feet Already Sold. IT IS GOOD!

GET THE FACTS

In Free Cable Test Booklet

Our descriptive booklet entitled, "The Story of 'MAJOR' Welding Cable" shows physical properties of rubber cable insulation, resistance to abrasion, to kerosene and other oils, facts on pliability and other interesting data. It compares "MAJOR" with all well-known brands. Because of the seriousness of our rubber supply you should have a copy of this study. Write for it TODAY.

"MAJOR" WELDING CABLE SPECIFICATIONS

Size	Amps	Strands	O.D.	I.D.	Wt. in lbs. per M ft.
6	75	950	.400	.210	132
4	125	1029	.495	.275	202
3	150	1323	.500	.305	235
2	200	1666	.560	.335	295
1	250	2156	.625	.400	373
1/0	300	2646	.675	.440	450
2/0	375	3381	.750	.490	570
3/0	450	4284	.815	.545	705
4/0	550	5376	.900	.635	860

Copper conductor consists of fine bare wires, properly stranded to give extreme flexibility.

A separator is applied over the conductor to strip rubber in order to leave bare copper for quick, clean attaching to lugs for electrode holders.

Rubber jacket has high tensile strength, maximum abrasion resistance. It is tough, durable, waterproof and extremely flexible.

OTHER "SAFEWELD" PRODUCTS

"TUFCORD" 2, 3, and 4-Conductor, heavy duty power cable

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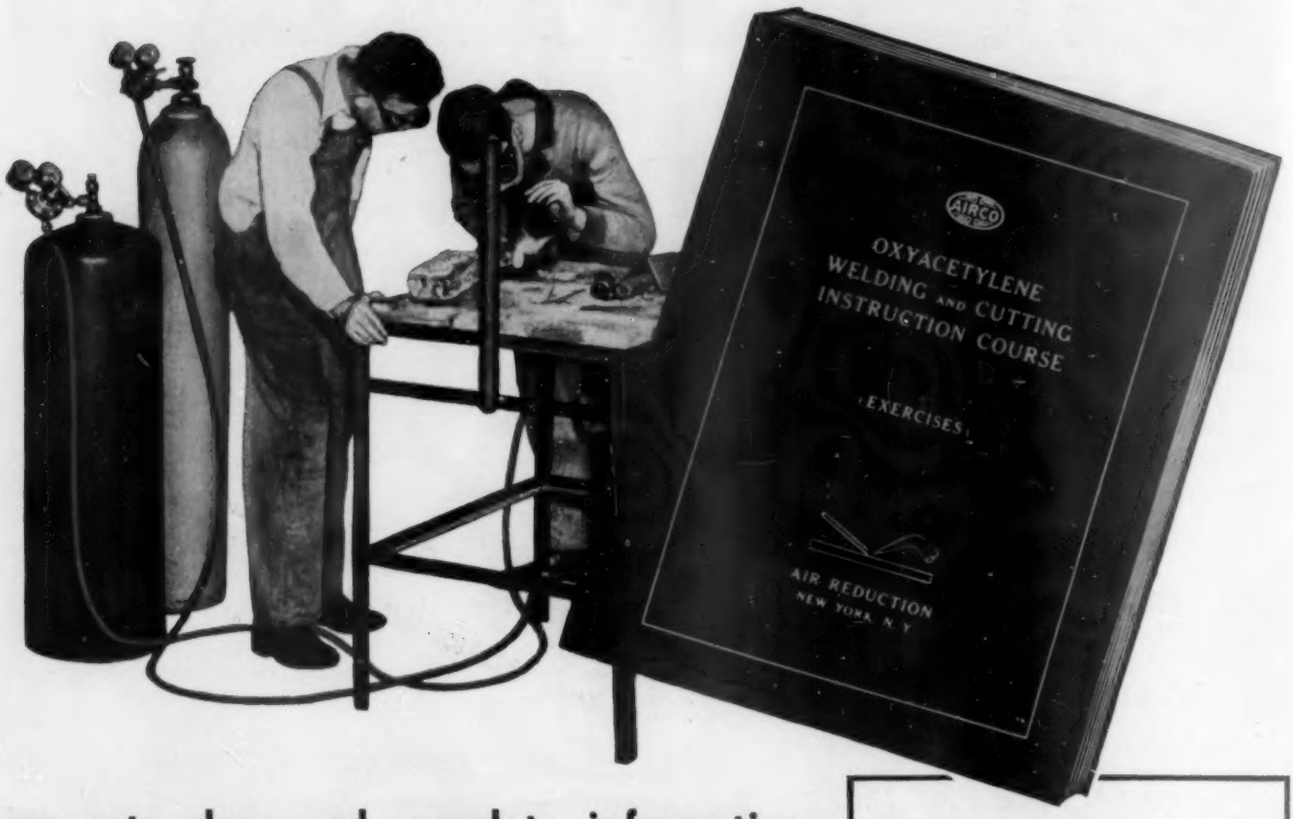

presents clear and complete information on OXYACETYLENE WELDING and CUTTING

This new book starts at rock bottom and leads the student progressively through the latest oxyacetylene welding and cutting methods. Carefully planned lessons presented in clear, understandable language are supplemented by practical tests and exercises that help indicate the student's progress.

This new Airco instruction book and its companion volume "Oxyacetylene Welding and Cutting Lectures" are ideal for self-training as well as for group training programs. Price $1 per copy; quantity prices on request. Free inspection privileges are provided.

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OXYGEN IS PRODUCTION — *Don't Waste it!*

FACTS *you should know about* HARD-FACING MATERIALS

By means of hard-facing—which is the process of welding on to wearing parts a coating, edge, or point of a hard metal—it is possible to protect metal surfaces that normally wear away rapidly in service. This method not only makes industrial parts last from two to twenty-five times longer, but also reduces time lost for replacements, lowers power consumption, and helps to maintain high efficiency. In addition, hard-facing often makes possible the use of substitute base metals in the fabrication of parts. Outlined below are facts you should know when selecting hard-facing rods.

Properties Required for Hard-Facing

High-quality materials are required to obtain full benefit from hard-facing. The materials should possess the following properties:

1. Inherent hardness.
2. Resistance to abrasion.
3. "Red Hardness"—or the retention of initial hardness up to red heat.
4. Ease of application by ordinary welding techniques.
5. Resistance to high-temperature oxidation during application by welding.
6. A melting point slightly lower than that of steel, the usual base metal.
7. A coefficient of expansion close to that of the base metal.

Types of Materials Available

Group 1—These alloys are relatively low in cost. They are alloy steels consisting of an iron base with less than approximately 20 per cent of alloying constituents. *Example: Hascrome iron-base hard-facing rod.*

Group 2—These are iron-base alloys containing more than 20 per cent of alloying elements. They are useful for services involving more severe abrasive wear than the metals of group 1. *Example: Haynes Stellite "93" hard-facing rod.*

Group 3—This group is made up essentially of non-ferrous cobalt-chromium-tungsten alloys. Hardness is inherent and retained at high temperatures. *Example: Haynes Stellite grades 1, 6, and 12 non-ferrous hard-facing rod.*

Group 4—The fourth group consists of tungsten carbide "diamond substitute" materials, supplied in a variety of forms, and combining a maximum of wear resistance with cutting qualities when applied on the cutting edges of earth drilling tools. *Example: Haystellite composite rod, tube rod, and inserts.*

Send for Helpful Literature

Write for the booklet *"Hard-Facing Materials Data."* It can be tacked on the shop wall for convenient reference on such points as the selection of the right rod, application techniques, and amount of rod required. A copy will be sent without charge.

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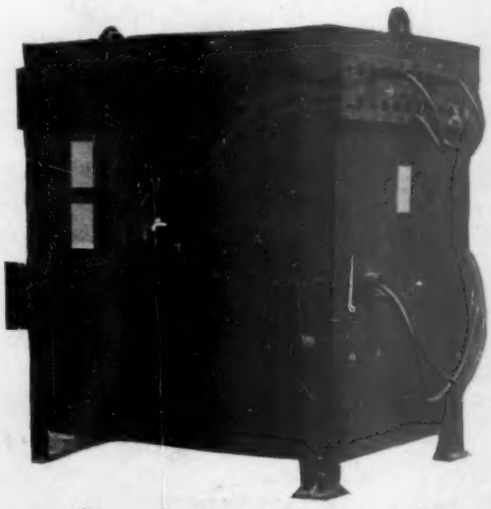
A Merry Christmas

and a Prosperous and Happy New Year

to our present and prospective customers, friends and competitors throughout the Welding Industry—and to all, except Hitler, Hirohito, Mussolini and their stooges.

To assure continued prosperity throughout the New Year and all the years to come, use the advanced products and engineering facilities of A.C. Headquarters:—



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